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ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE AUTOMATED SURFACE-WATER MONITORING

Water Year 2005 Annual Report

U.S. DEPARTMENT OF ENERGY

Rocky Flats Environmental Technology Site

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ACRONYMS

Acronym	Description
ac-ft	acre-feet
Ag	gold
ALF	Action Level and Standards Framework
Am	americium
AME	Actinide Migration Evaluation
AoI	Analyte of Interest
As	arsenic
Ba	barium
Be	beryllium
BMP	Best Management Practice
BZ	Buffer Zone
$CaCO_3$	calcium carbonate
CCA	Configuration Control Authority
Cd	cadmium
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation & Liability Act - "Superfund"
cfs	cubic feet per second
Cl	chlorine
cmp	corrugated metal pipe
Co	cobalt
CO_2	carbon dioxide
Cr	chromium
Cu	copper
D&D	Decontamination and Decommissioning
DER	Duplicate Error Ratio - calculated for real/duplicate radionuclide analyses
DOE	Department of Energy
DQO	Data Quality Objective
E	East
EPA	Environmental Protection Agency
ER	Environmental Remediation
Fe	iron

Acronym	Description
FIDLER	Field Instrument for the Detection of Low Energy Radiation
g	gram
GIS	Geographic Information System
GPS	Global Positioning Systems
HCO_3	bicarbonate
Hg	mercury
HRR	Historical Release Report
IA	Industrial Area
IAG	Interagency Agreement
IDLH	Imminent Danger to Life and Health
IHSS	Individual Hazardous Substance Site(s)
IM	Interim Measure
IMP	Integrated Monitoring Plan
IRA	Interim Remedial Action
ITS	Interceptor Trench System
K	potassium
K-H	Kaiser Hill Co., LLC
Li	lithium
LTL	Lower Tolerance Limit
MDA	Minimum Detectable Activity
MDL	Method Detection Limit
mg/L	milligrams per liter
Mo	molybdenum
N	North
NA	not applicable
Na	sodium
Ni	nickel
NO_3	nitrate
NPDES	National Pollutant Discharge Elimination System
NSD	New Source Detection
NSQ	Non-Sufficient Quantity
NTU	Nephlometric Turbidity Unit
P	phosphorus
PA	Protected Area
pCi/g	picoCurie per gram
pCi/L	picoCurie per liter
PNNL	Pacific Northwest National Laboratory
POC	Point of Compliance
POE	Point of Evaluation
POTW	Publicly Owned Treatment Works
Pu	plutonium
RCRA	Resource Conservation Recovery Act
RFCA	Rocky Flats Cleanup Agreement
RFCSS	Rocky Flats Closure Site Services
RFETS	Rocky Flats Environmental Technology Site
RFFO	Rocky Flats Field Office
RFPO	Rocky Flats Project Office
RI/FS	Remedial Investigation/Feasibility Study
RMRS	Rocky Mountain Remediation Services
RPD	Relative Percent Difference

Acronym	Description
S	South
Sb	antimony
Se	selenium
SID	South Interceptor Ditch
Sn	tin
SO_4	sulfate
SPCC	Spill Prevention Control and Counter-Measures
Sr	strontium
SSOC	Safe Sites of Colorado
SWD	Soil & Water Database
Tl	thallium
TSS	total suspended solids
U	uranium
ug	microgram
ug/L	microgram per liter
URS	URS Corporation
USFWS	United States Fish & Wildlife Services
UTL	Upper Tolerance Limit
UV	ultraviolet
V	vanadium
W	West
WQ	Water Quality
WWTP	Waste Water Treatment Plant
WY	Water Year
Zn	zinc

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1. EXECUTIVE SUMMARY

This Report presents the data collected to satisfy selected surface-water monitoring objectives implemented at the Rocky Flats Environmental Technology Site (RFETS or Site) in accordance with the *Rocky Flats Cleanup Agreement* (RFCA, [CDPHE et al, 1996]) and the *FY05 Integrated Monitoring Plan: Summary and Background Documents* (IMP; Kaiser-Hill, 2005a, 2005b). The IMP provides a framework for monitoring in support of closure activities at the Site. This framework includes implementation of a high-resolution surface-water monitoring program that supports data-driven decisions determined by the IMP Data Quality Objectives (DQO) process. The automated surface-water monitoring program provides:

- Monitoring of multiple parameters for the safe and effective operation of the Site retention ponds;
- Monitoring of flows and contaminant levels in subdrainages to facilitate the identification of contaminant sources;
- Monitoring of various surface-water parameters at various locations on an Ad Hoc basis in support of special projects and/or building operations;
- Monitoring of indicator parameter values at various locations to determine correlations between indicator parameters and analytical water-quality measurements;
- Detection of a release of contaminants from specific projects within the Industrial Area (IA);
- Detection of statistically significant increases of contaminants in surface water from within the IA in general;
- Detection of contaminants in comparison to RFCA Action Levels in discharges entering Stream Segment 5 and the Site retention ponds;
- Detection of contaminants in comparison to RFCA Standards in discharges entering Stream Segment 4 and at the Site boundary;
- Monitoring of indicator parameters in discharges leaving the Site boundary as a prudent management action; and
- Monitoring of flows and water quality in the Buffer Zone (BZ) for ecological and water rights issues, closure planning and design, as well as supporting studies regarding the interaction between media.

This report provides a comprehensive and detailed summary of the automated surface-water monitoring conducted at RFETS, which fulfills the applicable requirements of the Site IMP. As such, this report is organized to follow the framework of the IMP, with each report section providing the objective-specific data evaluations.

This report includes all data collected during WY05. The term 'water year' (abbreviated as WY) is defined as the period from October 1 through September 30. For example, WY05 refers to the period from 10/1/04 through 9/30/05.

As of October 13, 2005, Kaiser-Hill declared under the contract that "physical completion" had been achieved. This WY05 report is the last such report that Kaiser-Hill will produce. As of physical completion, Kaiser-Hill has reconfigured the surface-water monitoring network to the DOE Legacy Management specifications. With DOE acceptance of the physical completion of RFETS, implementation of all surface-water monitoring will transition to DOE Legacy Management.

1.1 MONITORING HIGHLIGHTS: WY05

During WY05, the automated surface-water monitoring network successfully fulfilled the targeted monitoring objectives as required by the Site IMP. At the start of WY05 the network consisted of 46 gaging stations, 13 precipitation gages, and 5 pond monitoring locations. During WY05 these locations collected 329 composite samples composed of 17,110 individual grabs.[1] During the year 32 monitoring locations were removed as the Site moved toward closure. One location (GS13; N. Walnut Creek above A-Series Ponds) was added during WY05. The post-closure monitoring network was completed to consist of 13 automated sampling locations, 15 flow measurement locations, 8 precipitation measurement locations, and 4 pond/piezometer monitoring locations.

WY05 was drier than average with approximately 12.2 inches of precipitation, which is 95% of average. The spring was drier than average with March, April, and May being 70% of average. October was significantly wetter than average (252% of average), while July and September were significantly drier than average (34% and 23% of average, respectively). The largest events occurred on 8/4/05 (0.99") and 10/6/04 (0.75").[2] The largest two-day total (1.44") occurred on 8/3 – 8/4/05. The highest peak flow rates for the year from the IA were during the 10/6/04 event (~0.6" inches in 2 hours and 40 minutes; with ~0.11" in 15 minutes).[3] Peak flows were 15.4 cubic feet per second [cfs] in North Walnut Creek, 17.4 (estimated) cfs in South Walnut Creek, and 5.4 cfs in the South Interceptor Ditch. Due to the removal of impervious surface and the completion of the functional channels, peak flows for the 8/4/05 event were only 3.5 cfs (N. Walnut) and 5.0 cfs (S. Walnut); there was no flow in the SID for this event.

All water-quality data at the RFCA Points of Compliance (POCs) were below the applicable standards during WY05. For the RFCA Points of Evaluation (POEs), reportable values were observed at GS10 (Pu, Am, total uranium, chromium), SW027 (Pu), and SW093 (Pu). These reportable values for WY05 were addressed through multiple source evaluation letters from DOE to the Regulators. These WY05 notifications are summarized in Section 6 of this report.

Conclusions for the WY05 POE Source Evaluations are:

- The Site retention ponds continue to effectively remove suspended solids and any associated contamination from the water column. Pu and Am activities at the terminal pond and fenceline POCs remain well below reporting thresholds.
- Based on the details regarding recent Site activities, it is concluded that various D&D, construction, ER, and excavation operations resulted in increased transport of low-level contamination associated with suspended solids in surface water that are likely to have resulted in the recent reportable values measured at the GS10 (Pu, Am, Cr), SW027 (Pu), and SW093 (Pu).
- With the physical completion of the Site, turbidities (an indication of TSS) and TSS levels relative to flow rate show a measurable improvement. Targeted erosion controls and functional channel construction have proven to be effective in measurably reducing both sediment transport and constituent concentrations. As of the end of WY05, all of the POEs were showing Pu and Am concentrations well below the action level. In the long-term, with the completion of the removal of impervious areas resulting in decreased runoff, the stabilization of soils within the drainages, and the progression of revegetation, water quality is expected to continue to improve.
- Surface-water data from GS10 show that the reportable uranium concentrations are associated with lower flow rates, during periods of extended baseflow sustained by groundwater contributions in the form of seeps and distributed flow to the streambed. As the impervious surface at the Site was eliminated, direct runoff to GS10 was also reduced, and groundwater contributions to S. Walnut Cr. made up a larger portion of the flows monitored at GS10. Without the mixing of uranium groundwater sources with direct surface runoff, increases in surface-water uranium concentrations are

[1] Composite samples consist of multiple aliquots ('grabs') of identical volume. Each grab is delivered by the automatic sampler to the composite container at each predetermined flow-volume or time interval.

[2] The precipitation gages used in the Automated Surface-Water Monitoring Network are not heated due to the lack of AC power at the locations. As such, the gages do not accurately measure snowfall (as water equivalent) as it occurs.

[3] GS10 measured a peak flow of 44.6 (estimated) cfs on 4/11/05 due to the planned breach of a coffer dam as part of the construction of Functional Channel 5.

expected. Groundwater data within S. Walnut Cr. show naturally-occurring uranium activities considerably higher than the surface-water action level.

- Recent HR ICP/MS and TIMS analyses for both groundwater and surface-water samples collected upstream of GS10 all show a natural uranium signature. While the single analysis of surface-water from GS10 indicates the existence of some depleted uranium, the normal variability of direct runoff and groundwater flow would be expected to strongly influence the uranium characteristics, both concentration and signature, over longer periods. To fully understand this variability, additional uranium data as it relates to the appropriate water-quality action level, would need to be evaluated.

New Source Detection (NSD) monitoring, for the five major runoff pathways (sub-drainage areas) from the IA to the ponds, indicated statistically significant changes in water quality at GS10 and SW093 (see Section 10) during WY05. These changes were addressed by Source Evaluations under the POE monitoring objective. Source Location monitoring upstream of POEs GS10, SW027, and SW093 continued to characterize these drainage areas. WY05 data continue to support the conclusions regarding actinide transport mechanisms detailed in previous source evaluation reports for GS10, SW027, and SW093 (see Section 6).

Performance monitoring of closure projects at the Site was enhanced with the addition of two new locations. Location GS61 and SW018 were installed to support the demolition of B371/374. Data from Performance locations continued to show that most Site projects were not significantly affecting water quality in WY05, confirming the effectiveness of the administrative and engineering controls intended to protect surface water. The Performance monitoring data was also instrumental in the success of POE source evaluations.

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2. INTRODUCTION

2.1 PURPOSE

This Report presents data collected at automated surface-water monitoring locations at the Site in accordance with the RFCA and the IMP. The IMP provides a framework for monitoring in support of transition activities at the Site. This framework includes implementation of a high-resolution surface-water monitoring program that supports data-driven decisions determined by the IMP DQO process. This automated monitoring program is intended to provide:

- Monitoring of multiple parameters for the safe and effective operation of the Site retention ponds;
- Monitoring of flows and contaminant levels in subdrainages to allow for the location of contaminant sources;
- Monitoring of various surface-water parameters at various locations on an Ad Hoc basis in support of special projects and/or building operations;
- Monitoring of indicator and field parameters at various locations to provide enhanced analytical data assessment;
- Detection of a release of contaminants from specific projects within the IA;
- Detection of statistically significant increases of contaminants in runoff from within the IA in general;
- Detection of contaminants in comparison to RFCA Action Levels in discharges entering Stream Segment 5 and the Site retention ponds;
- Detection of contaminants in comparison to RFCA Standards in discharges entering Stream Segment 4 and at the Site boundary;
- Monitoring of indicator parameters in discharges leaving the Site boundary as a prudent management action; and
- Monitoring of flows and water quality in the Buffer Zone (BZ) for ecological and water rights issues, as well as supporting studies concerning interactions between media.

2.2 SCOPE

This Report includes:

- A description of the site automated surface-water monitoring program and monitoring network;
- A presentation of discharge and precipitation data summary statistics;
- A summary of selected analytical water-quality results;
- A loading analysis for selected radionuclides at POEs and POCs;
- An evaluation of analytical results as required by the Site IMP, organized by monitoring objective;[4]
- A presentation and evaluation of real-time water-quality data;
- An appendix with hydrologic and water-quality data; and
- A compact disc with the document, appendices, and appendix tables in digital format.

[4] Evaluation of analytical data for the Performance Monitoring (Section 9) and Indicator Parameter (Section 8) are not included in this report. These objectives were designed to support closure of the Site. With the Site now "physically complete", ongoing evaluation of these data is no longer needed; data are given in the appendices.

2.3 BACKGROUND

2.3.1 Environmental History

Processing and fabrication of weapons-related components began at the Site in 1952 and continued through 1989. Fabrication of stainless steel components continued in one building, however, through the early 1990s. During operation, environmental protection measures were established that seemed consistent with prudent environmental management. However, some activities resulted in the environmental contamination of portions of the Site. Efforts to document the extent of Site contamination became a major focus in the 1980s and continue today in accordance with the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the RFCA, a cooperative agreement between U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and Colorado Department of Public Health and Environment (CDPHE). In addition, a historical release report (HRR) (DOE, 1992) has been developed that documents contamination from past practices. The HRR is updated on an annual basis with the knowledge gained from ongoing monitoring and investigation activities. The additional information is submitted on an annual basis to the EPA and CDPHE as addenda to the original document.

Documented areas of soil contamination have been designated as Individual Hazardous Substance Sites (IHSSs). Many of these IHSSs have been characterized as part of the Remedial Investigation/Feasibility Study (RI/FS) process which was conducted under the Interagency Agreement (IAG, 1991) between DOE, CDPHE, and EPA. All IHSSs scheduled for remediation have been completed.

2.3.2 Rocky Flats Cleanup Agreement

The RFCA was adopted on July 19, 1996 (CDPHE et al, 1996). The RFCA replaced the IAG as the environmental cleanup agreement for RFETS. The RFCA contains the requirements for the environmental cleanup. The Action Level Framework (ALF) attachment to the RFCA contains specific requirements for environmental monitoring and reporting, and it sets action levels for contaminant concentrations in surface water and in other media. The IMP is required under RFCA to further define the monitoring programs for the Site.

To align the surface-water monitoring program with the new RFETS mission and RFCA requirements, the monitoring network was evaluated in 1996. The DQO process was used to determine what decisions were necessary for surface water and the function of each location in the network in supporting those decisions. DOE, CDPHE, EPA, and stakeholders were directly involved in decisions involving the monitoring network. Results of this evaluation were integral to the development of the IMP, which is discussed below.

2.3.3 Integrated Monitoring Plan for Surface Water

The Site automated surface-water monitoring network is designed to meet the requirements documented in the Site IMP, which groups all Site surface-water monitoring objectives into five primary categories: Site-Wide, Industrial Area, Industrial Area Discharges to Ponds, Water Leaving the Site, and Off-Site. The nine IMP objectives that are accomplished through the automated monitoring are described briefly below.[5] During WY05, the Site monitoring network included 46 gaging stations, 13 precipitation gages, and 5 pond monitoring locations (Figure 2-1) to achieve these objectives.[6] In some situations, the same location may serve multiple objectives. Monitoring tasks and data collection, compilation, evaluation, and reporting for each objective included in this report are detailed in Sections 6 through 14. Figure 2-2 shows the monitoring network at the end of WY05, after reconfiguration to DOE Legacy Management specifications.

The IMP used the DQO process to determine necessary and sufficient monitoring requirements. The process yielded multiple, data-driven, surface-water monitoring objectives (called decision rules under the DQO process), a subset of which (10) is implemented through automated monitoring. The remaining IMP objectives are

[5] The IDLH decision rule (locations indicated in Table 2-1) requires the collection of hydrologic data to support the management of the Site retention ponds. This objective does not require any detailed data analysis. Therefore, this decision rule is not included in this report, however, hydrologic data are presented here for completeness.

[6] The period of operation of these locations varies based on project needs and regulatory requirements.

implemented by other RFETS projects and governmental agencies. Some decisions need a higher priority than others, and some need greater confidence. The DQO process produced descriptions that expose the strengths and weaknesses of each data-driven decision and the value of the data (and resources required) to make each decision. Management decisions often must be made based on incomplete information. The individual DQO sections of the IMP document guide management in establishing funding priorities for surface-water monitoring objectives.

Five of the IMP automated surface-water monitoring objectives are organized in a roughly upstream-to-downstream direction, beginning with Performance monitoring within the IA and ending downstream at the POCs at Indiana Street (Figure 2-3). These monitoring objectives are summarized in the following paragraphs and are discussed in detail in Sections 9 through 13.

For the first of the upstream-to-downstream monitoring categories (IA Objectives), the IMP requires the Site to characterize significant surface-water releases within the IA. Within the IA (usually), individual high-risk projects will sometimes warrant Performance monitoring (Section 9) to detect a spill or release of contaminants specifically associated with that project.

For the next upstream-to-downstream monitoring category (IA Discharges to Ponds / Segment 5 Objectives), the IMP requires the Site to identify and correct significant accidental or undetected releases of contaminants from the IA to the Site retention ponds (surface water leaving the IA and entering Segment 5). The New Source Detection (Section 10) and POE (Section 11) objectives deal with discharges from the IA to the ponds. To decide whether a significant release has occurred, the Site performs NSD monitoring of IA runoff for significant changes in contaminant concentrations. Additionally, RFCA specifies Stream Segment 5 / POE monitoring for the upstream reaches of Site drainages (above the ponds) and specifies action levels for contaminants (Action Level Framework).

The next category is Water Leaving the Site (Segment 4 Objectives). The Site is required to monitor at POC locations below the terminal ponds to protect state stream standards in Segment 4 (Section 12), as specified in RFCA. In addition, there are RFCA POCs that are located at the Site boundary at Indiana Street (Section 12) for both Walnut and Woman Creeks. The Non-POC decision rule (Section 13) also requires the Site to collect data for selected water-quality parameters at the Indiana Street POCs.

Monitoring objectives that do not fit into the upstream-to-downstream sequence are considered as Site-Wide Monitoring Objectives. Monitoring in support of these objectives can occur at any location within the Site boundary.

For example, Imminent Danger to Life and Health (IDLH) monitoring provides information necessary for safe operation of the Site retention pond dams. This monitoring objective is not discussed in this document; however the hydrologic data associated with this decision rule are presented in Section 3.

Figure 2-1. RFETS Automated Surface-Water Monitoring Locations and Precipitation Gages: Start of WY05 (Map Insert).

Figure 2-2. RFETS Automated Surface-Water Monitoring Locations and Precipitation Gages: End of WY05 (Map Insert).

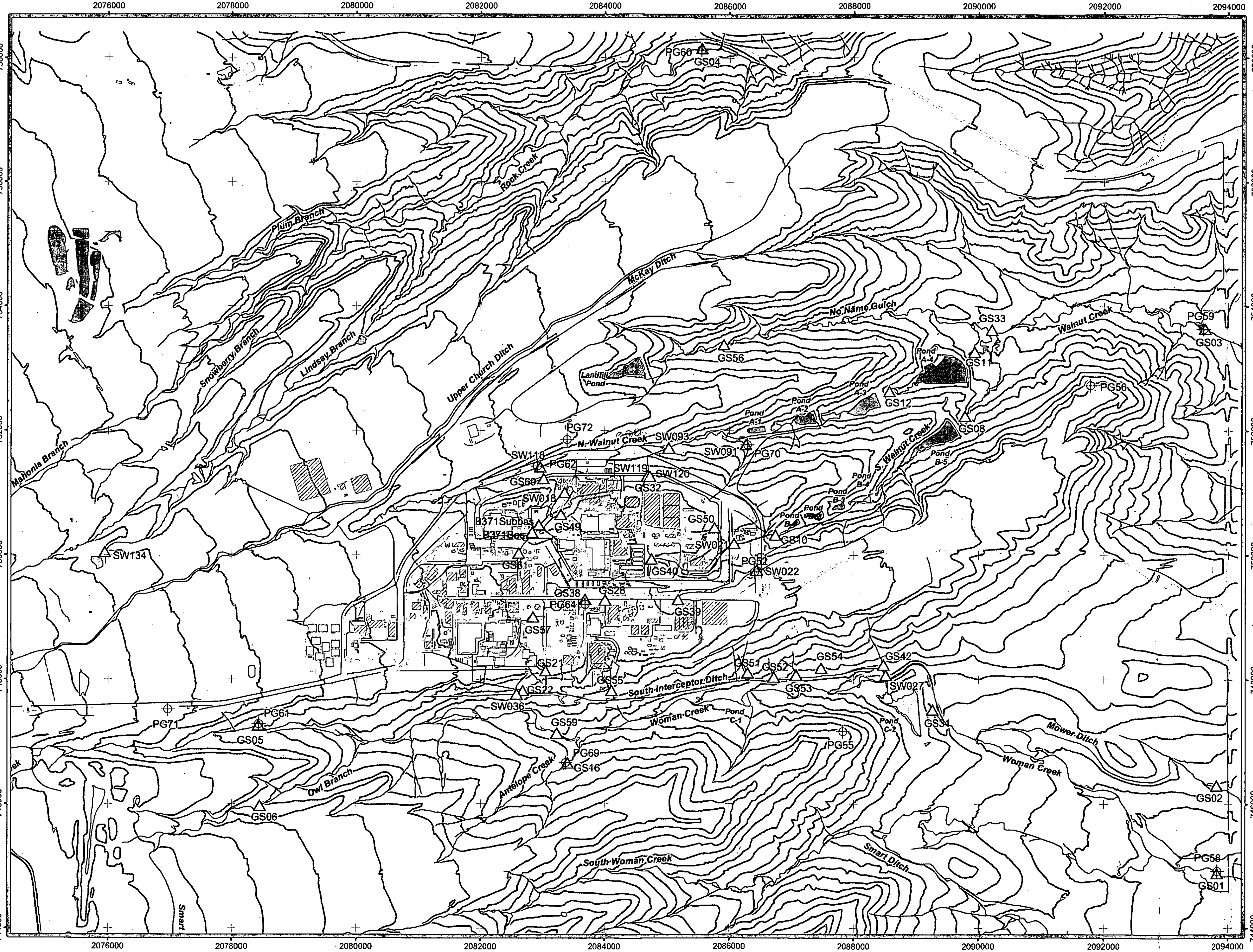

Figure 2-1

RFETS Automated Surface Water Monitoring Locations and Precipitation Gages: Start of WY05

EXPLANATION

- Precipitation Gage
- Automated Surface Water Monitoring Location

Standard Map Features

- Buildings and other structures
- Demolished buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Paved roads
- Topographic contour (20-foot)
- Rocky Flats Environmental Technology Site boundary

DATA SOURCE BASE FEATURES:

Buildings, fences, hydrography, roads, and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

Topographic contours were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. DEM post-processing performed by MK, Winter 1997.

N
W E
S

0 800 1,600 2,400 3,200 Feet

Scale 1:19,200

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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November 15, 2005

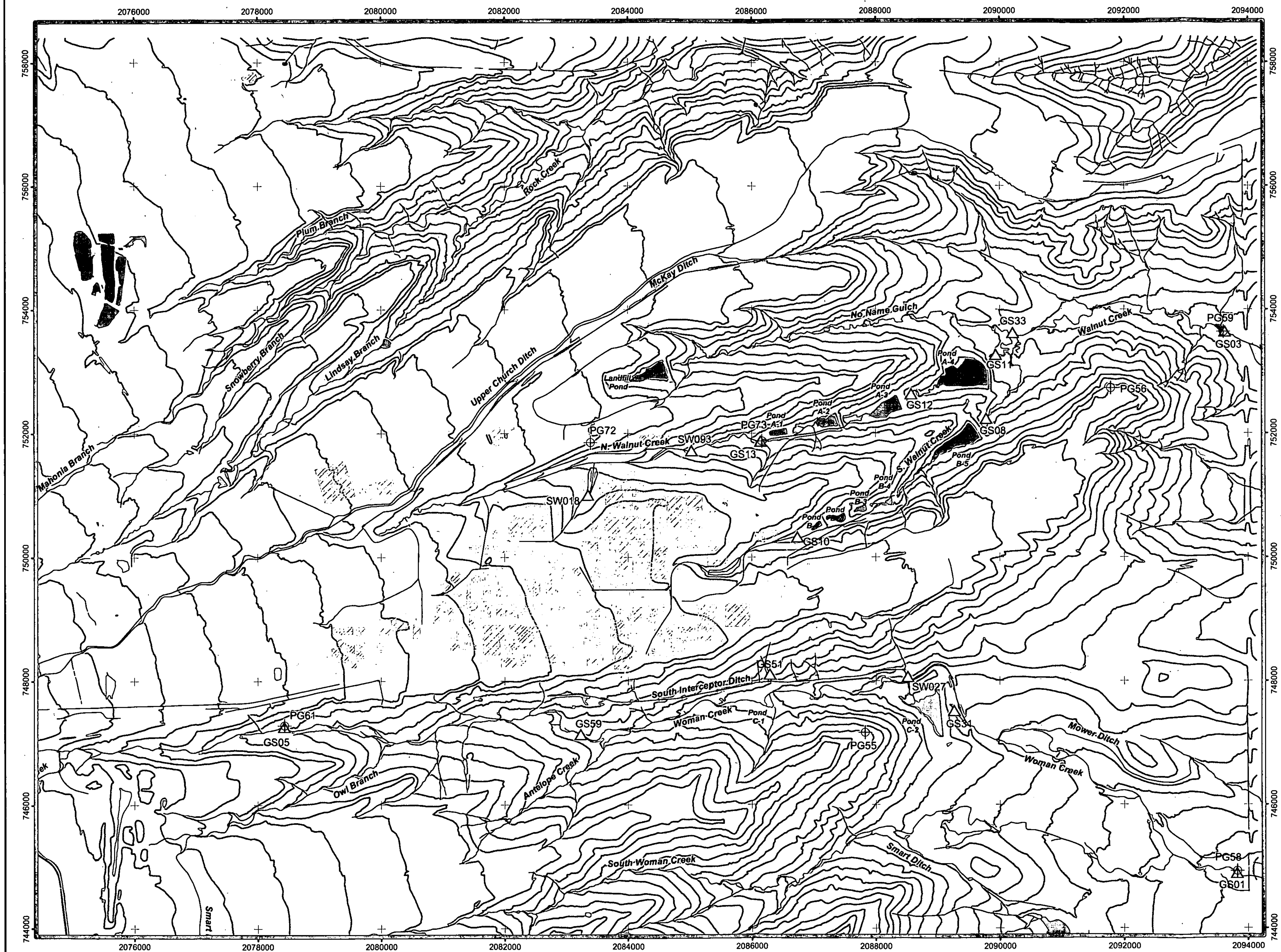

Figure 2-2

RFETS Automated Surface Water Monitoring Locations and Precipitation Gages: End of WY05

EXPLANATION

- Precipitation Gage
- Automated Surface Water Monitoring Location

Standard Map Features

- Buildings and other structures
- Demolished buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Paved roads
- Topographic contour (20-foot)
- Rocky Flats Environmental Technology Site boundary

DATA SOURCE BASE FEATURES:

Buildings, fences, hydrography, roads, and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

Topographic contours were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. DEM post-processing performed by MK, Winter 1997.

N
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0 800 1,600 2,400 3,200 Feet

Scale 1:19,200

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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November 15, 2005

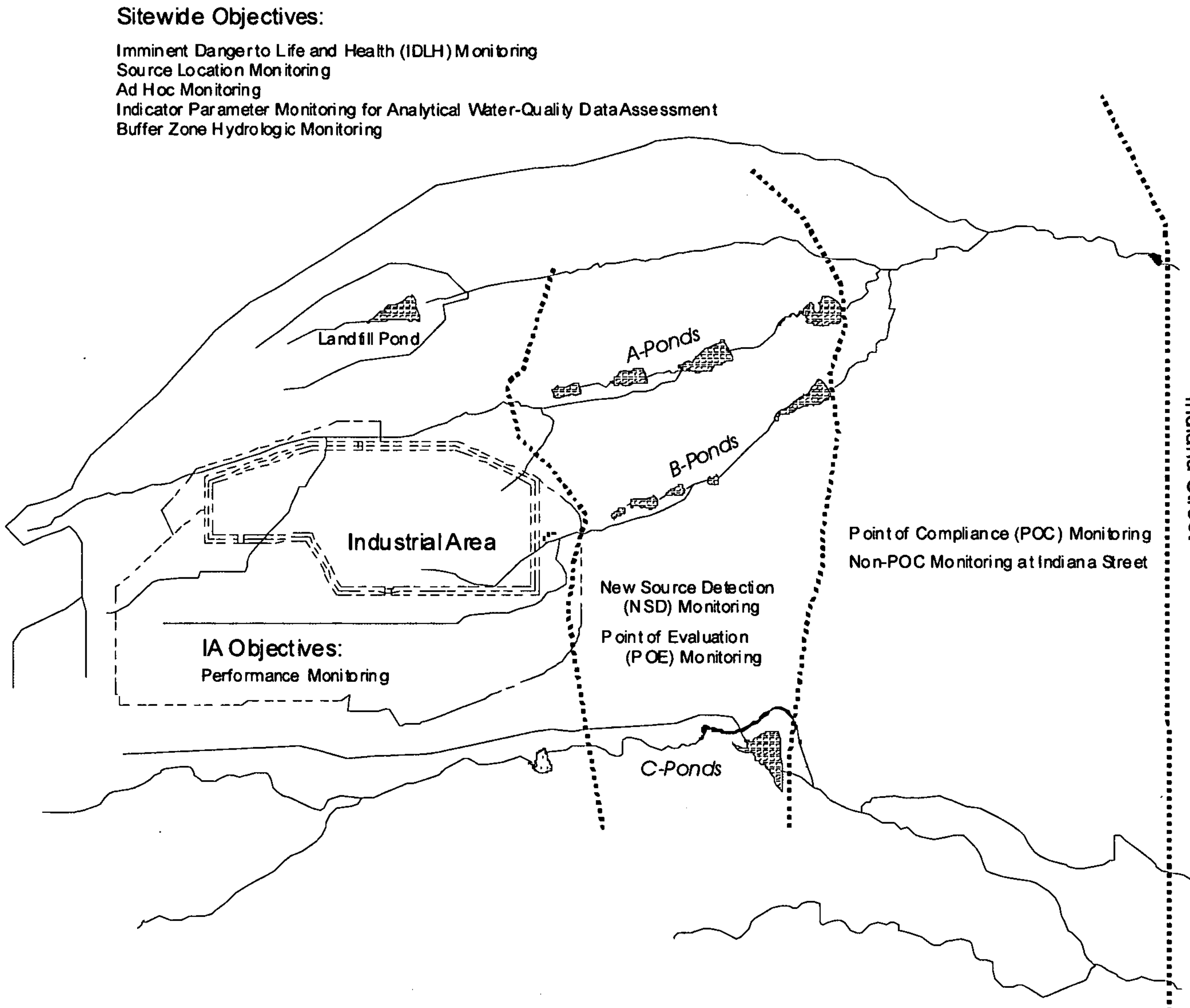

Figure 2-3. Conceptual Model of Site Automated Surface-Water Monitoring Objectives.

Another site-wide monitoring objective, Source Location monitoring (see Section 6), is designed to locate a source of contamination detected by other monitoring objectives, and can take place anywhere within the Site boundary. Unplanned, special-request monitoring activities are discussed as Ad Hoc monitoring in Section 7.

Indicator Parameter Monitoring for Analytical Water-Quality Data Assessment (Section 8) is also implemented site-wide. This objective provides the justification for the collection of general water-quality and quantity information to be used for various data assessments. Specifically, this objective outlines the current and expected uses of parameters such as TSS, turbidity, and flow rate.

Finally, Buffer Zone Hydrologic monitoring occurs at various locations across the Site and addresses the interactions between surface water and other media: soil, groundwater, air, and ecology (Section 14).

Table 2-1. Matrix of Monitoring Locations and Supported IMP Decision Rules: WY05.

	Supported Decision Rule										
Location Code	**IDLH**	**Source Location**	**Ad Hoc**	**Indicator Parameter**	**Performance**	**New Source Detection**	**POE**	**POC**	**Non-POC**	**BZ Hydro**	**Precip-itation**
GS01				✓				✓	✓	✓	✓
GS02										✓	
GS03				✓				✓	✓	✓	✓
GS04				✓						✓	✓
GS05										✓	✓
GS06										✓	
GS08	✓			✓				✓			
GS10	✓			✓		✓	✓				
GS11	✓			✓				✓			
GS12	✓										
GS16										✓	✓
GS21		✓		✓	✓						
GS22		✓		✓	✓						
GS28		✓		✓	✓						
GS31	✓			✓				✓			
GS32		✓		✓	✓						
GS33			✓								
GS38		✓		✓	✓						
GS39		✓		✓	✓						
GS40		✓		✓	✓						
GS42		✓		✓	✓						
GS49		✓		✓	✓						
GS50		✓		✓	✓						
GS51		✓		✓	✓						
GS52		✓		✓	✓						
GS53		✓		✓	✓						
GS54		✓		✓	✓						
GS55		✓		✓	✓						
GS56				✓	✓						
GS57		✓		✓	✓						
GS59				✓	✓						
GS60		✓		✓	✓						
GS61		✓		✓	✓						
SW018		✓		✓	✓						
SW021		✓		✓	✓						
SW022		✓		✓		✓					✓
SW027	✓			✓		✓	✓				
SW036		✓		✓	✓						
SW091				✓	✓	✓					✓
SW093	✓			✓		✓	✓				
SW118										✓	✓
SW119		✓		✓	✓						
SW120		✓		✓	✓						
SW134				✓						✓	
B371BAS			✓								
B371SUBBAS			✓								
A3DM	✓										
A4DM	✓										
B5DM	✓										
C2DM	✓										
LFDM	✓										
RPTR											✓
RPTR2											✓
RPTR3											✓

Note: Many locations provide flow data to the Site-Wide Water Balance as Ad Hoc locations. Only those locations specifically installed as Ad Hoc locations are noted above.
Locations A3DM, A4DM, B5DM, C2DM, and LFDM are telemetry nodes collecting real-time pond level and piezometer data for the IDLH decision rule. These data are not evaluated in this report.

2.4 SETTING

2.4.1 Site Description

The Site is a government-owned, contractor-operated facility in the DOE nuclear weapons complex, located in Golden, Colorado. The Site is owned by the DOE, managed by the DOE Rocky Flats Project Office (DOE, RFPO), and operated by Kaiser-Hill Company, L.L.C. (K-H).

The automated surface-water monitoring program is managed by K-H and implemented at multiple sampling locations throughout the Site. Figure 2-1 shows the locations of the automated surface-water monitoring locations operated during WY05 that are included in this report.

2.4.2 Hydrology

Streams and seeps at RFETS are largely ephemeral, with stream reaches gaining or losing flow, depending on the season and precipitation amounts. Surface-water flow across RFETS is primarily from west to east, with three major drainages traversing the Site. Fourteen retention ponds (plus several small stock ponds) collect surface-water runoff, although only ten ponds are actively managed. The Site drainages and retention ponds, including their respective pertinence to this report, are described below and shown on Figure 2-4. Figure 2-5 shows the final Site configuration as of the end of WY05.

Walnut Creek

Walnut Creek receives surface-water flow from the central third of RFETS, including the majority of the IA. It consists of several tributaries: McKay Ditch, No Name Gulch, North Walnut Creek, and South Walnut Creek. These tributaries join Walnut Creek prior to the RFETS eastern boundary (Indiana Street). East of Indiana Street, Walnut Creek flows through a diversion structure normally configured to divert flow to the Broomfield Diversion Ditch around Great Western Reservoir and into Big Dry Creek. The Walnut Creek tributaries, from north to south, are described below:

McKay Ditch

The McKay Ditch was formerly a tributary to Walnut Creek within the RFETS boundaries but was diverted in July 1999 into a new pipeline to keep McKay Ditch water from co-mingling with RFETS water in Walnut Creek. Although no longer a contributor to Walnut Creek, the McKay Ditch drainage is described here to clarify water routing at the Site. The new configuration allows the City of Broomfield to transport water from the South Boulder Diversion Canal, across the northern Rocky Flats BZ and directly into Great Western Reservoir without entering Walnut Creek. This configuration prevents commingling of McKay water with discharged water from the Site retention ponds.

No-Name Gulch

This drainage is located downstream of the Present Landfill and Landfill Pond. A surface-water diversion ditch was constructed around the perimeter of the Present Landfill in 1974 to divert surface-water runoff around the landfill and reduce infiltration of surface water into the landfill. On the north side of the landfill, the ditch runs under a perimeter road through a small culvert and east into a small, natural drainage that eventually joins No Name Gulch below the Landfill Pond dam. On the south side of the landfill, the ditch runs east above the Landfill Pond and drops into No Name Gulch below the dam. The Landfill Pond covers approximately 2.5 acres. Surface-water from the landfill and from the area surrounding the pond is a major contributor to pond water. Some portion of the runoff is diverted by the surface-water diversion ditch, while a significant fraction flows to the Landfill Pond. Water is periodically transferred to the A-Series Ponds to control the water level in the Landfill Pond. Runoff from the IA does not flow into this basin.

North Walnut Creek

Runoff from the northern portion of the IA flows into this drainage, which has four retention ponds (Ponds A-1, A-2, A-3, and A-4). The combined capacity of the A-Series Ponds is approximately 197,000 cubic meters (m^3; 52 million gallons; 160 acre-feet). In the normal operational configuration, Ponds A-1 and A-2 are bypassed and maintained for emergency spill control; evaporation or transfer controls water levels in these ponds. The A-Series Ponds also receive water pumped from the Landfill Pond roughly once per year. North Walnut Creek flow is diverted around Ponds A-1 and A-2 to Pond A-3 for detainment and settling of solids. Pond A-3 is discharged in batches to the A-Series "terminal pond", Pond A-4. After filling to a maximum safe level (typically approximately 50 percent of capacity), Pond A-4 water is isolated, sampled, and released if surface-water quality criteria are met. These off-site batch discharges, each averaging approximately 49,100 m^3 (13.0 million gallons; 39.8 acre-feet), currently occur 2 to 4 times per year.

South Walnut Creek

Runoff from the central portion of the IA flows into this drainage, which has five retention ponds (Ponds B-1, B-2, B-3, B-4, and B-5). The combined capacity of the South Walnut Creek B-Series Ponds is approximately 102,000 m^3 (27 million gallons; 83 acre-feet). Ponds B-1 and B-2 are bypassed and maintained for emergency spill control; evaporation or transfer controls water levels in these ponds. Until October 2004, Pond B-3 received effluent from the Site's WWTP and flows into Pond B-4. South Walnut Creek flow is diverted around Ponds B-1, B-2, and B-3, and into Pond B-4, which flows continuously into "terminal pond" Pond B-5. After filling to a maximum safe level, Pond B-5 water is sampled and released if surface-water quality criteria are met. Pond B-5 is released in batches of approximately 41,100 m^3 (13.5 million gallons; 41.4 acre-feet) to South Walnut Creek. Pond B-5 discharges currently occur 6 to 8 times per year.

South Interceptor Ditch

South of the IA is the South Interceptor Ditch (SID)/Woman Creek drainage system. Although it is tributary to Woman Creek, the SID warrants more thorough discussion than other comparable tributaries at the Site because it captures runoff from the southern portion of the IA, a drainage basin that includes the Original Landfill and the 903 Pad/Lip.

Surface-water runoff from the southern portion of the IA is captured by the SID, which flows from west to east into Pond C-2. After 1992, Pond C-2 was pump discharged to the Broomfield Diversion Ditch after reaching a pre-designated level. Starting in January 1997, water from Pond C-2 is sampled and, if downstream surface-water quality is met, pump discharged into Woman Creek which flows to the Woman Creek Reservoir. (See the Woman Creek description below.) These off-site discharges from Pond C-2, each averaging approximately 36,700 m^3 (9.7 million gallons; 29.8 acre-feet), currently occur less than once per year.

Woman Creek

South of the SID is Woman Creek, which flows through Pond C-1 and off-site at Indiana Street. The Woman Creek drainage basin extends eastward from the base of the foothills, near Coal Creek Canyon, to Standley Lake. In the current configuration, Woman Creek flows into the Woman Creek Reservoir located upstream of Standley Lake, where the water is held until it is pump transferred to Big Dry Creek by the City of Westminster.

Other Drainages

The third major drainage at the Site, other than Walnut and Woman Creeks, is Rock Creek. The Rock Creek drainage covers the northwestern portion of the Site Buffer Zone (BZ). East sloping alluvial plains to the west, several small stock ponds within the creek bed, and multiple steep gullies and stream channels to the east characterize the drainage channel. This basin receives no runoff from the IA.

Smart Ditch, located south of Woman Creek, is also hydrologically isolated from the IA. The D-Series Ponds (D-1 and D-2) are located on Smart Ditch. This drainage and these ponds are not discussed in this report.

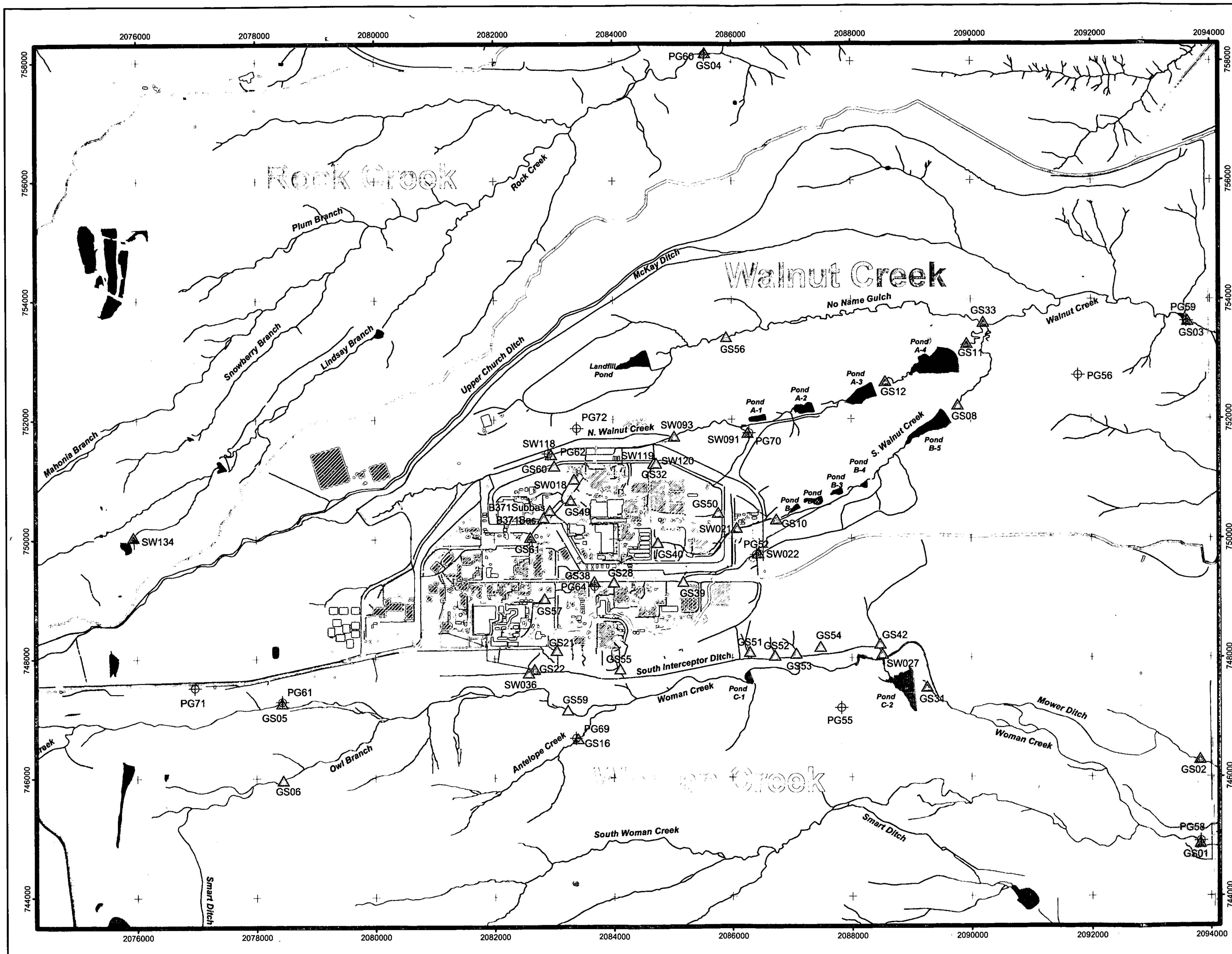

Figure 2-4
Major Site Drainage Areas: Walnut Creek, Woman Creek, and Rock Creek at Start of WY05

EXPLANATION

- Precipitation Gage
- Automated Surface Water Monitoring Location

Standard Map Features

- Buildings and other structures
- Demolished buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Paved roads
- Rocky Flats Environmental Technology Site boundary

DATA SOURCE BASE FEATURES:

Buildings, fences, hydrography, roads, and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

Topographic contours were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. DEM post-processing performed by MK, Winter 1997.

N E S W

0 800 1,600 2,400 3,200 Feet

Scale 1:19,200

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental
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November 15, 2005

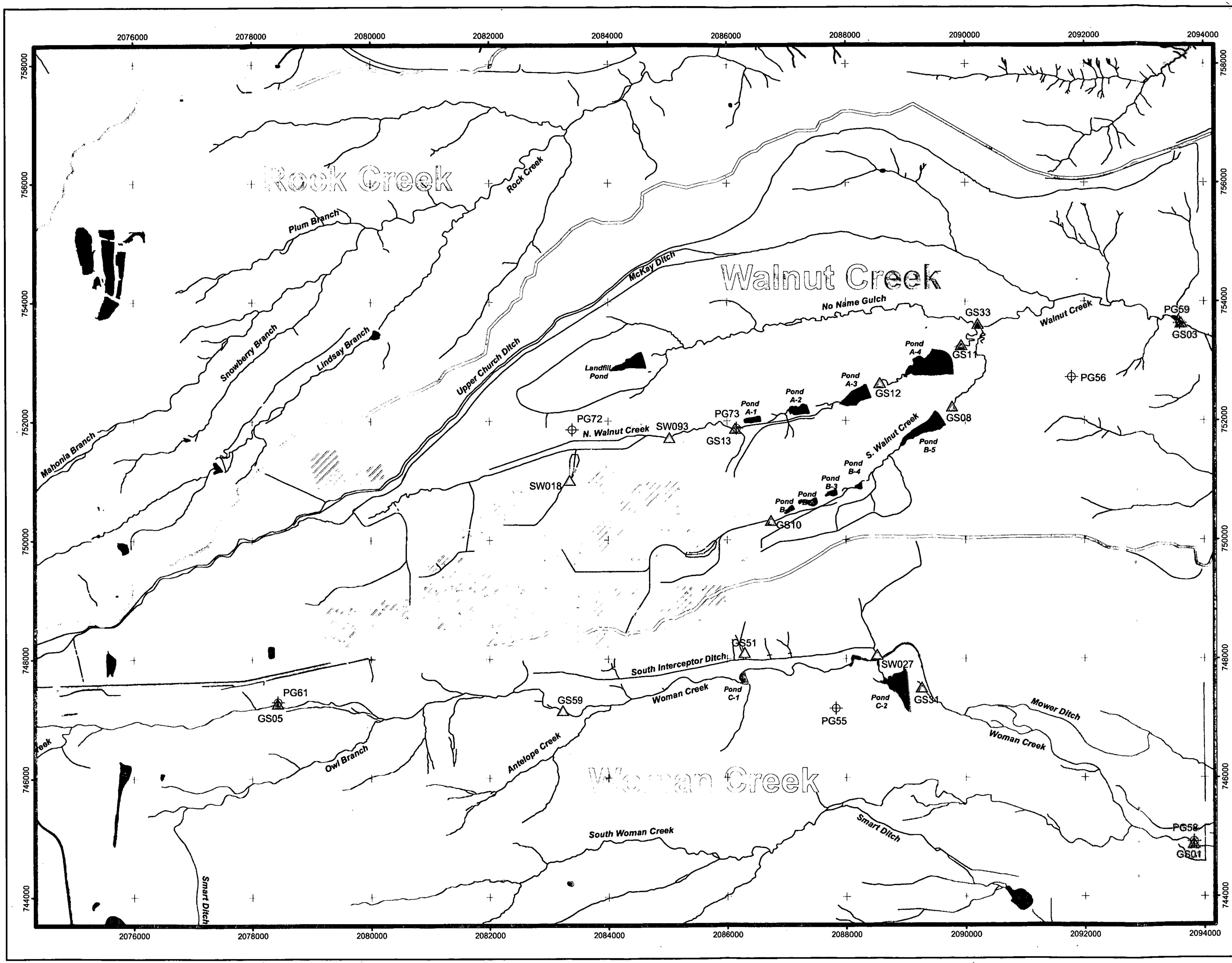

Figure 2-5

Major Site Drainage Areas: Walnut Creek, Woman Creek, and Rock Creek at End of WY05

EXPLANATION

- Precipitation Gage
- Automated Surface Water Monitoring Location

Standard Map Features

- Buildings and other structures
- Demolished buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Paved roads
- Rocky Flats Environmental Technology Site boundary

DATA SOURCE BASE FEATURES:

Buildings, fences, hydrography, roads, and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

Topographic contours were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. DEM post-processing performed by MK, Winter 1997.

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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3. HYDROLOGIC DATA

The following section provides information on all automated surface-water monitoring locations at RFETS that operated during WY05. Some locations do not have a continuous flow record; they were operated only to collect automated surface-water samples for laboratory analysis. For locations with continuous flow measurement, graphical discharge summaries are provided. Numerical discharge values are included in the tables in Appendix A. The hydrologic routing diagrams for the locations included in this report are shown in Figure 3-1 and Figure 3-2.[7] Figure 3-3 shows the reconfigured hydrologic routing as of the end of WY05.

3.1 DATA PRESENTATION

3.1.1 Discharge Data Collection and Computation

Data obtained at a continuous surface-water gaging station on a stream or conveyance, such as an irrigation ditch, consist of a continuous record of stage[8], individual measurements of discharge throughout a range of stages, and notations regarding factors that might affect the relation of stage to discharge. These data, together with supplemental information such as climatological records, are used to compute daily mean discharges.

Continuous records of stage are obtained with electronic recorders that store stage values at selected time intervals or secondarily with radio-telemetry data-collection platforms that transmit near real-time data at selected time intervals to a central database for subsequent processing. Direct field measurements of discharge are made with current meters, using methods adapted by the USGS, or with flumes or weirs that are calibrated to provide a relation of observed stage to discharge. These methods are described by Carter and Davidian (1968) and by Rantz and others (1982).

In computing discharge records for non-standard flow-control devices, results of individual measurements are plotted against the corresponding stage, and stage-discharge relation curves are constructed. From these curves, rating tables indicating the computed discharge for any stage within the range of the measurements are prepared. For standard devices (e.g., flumes, weirs), rating tables indicating the discharge for any stage within the range of the device are prepared based on the geometry of the device. If it is necessary to define extremes of discharge outside the range of the device, the curves can be extended using (1) logarithmic plotting, (2) velocity-area studies, (3) results of indirect measurements of peak discharge, such as slope-area or contracted-opening measurements, and computation of flow over dams or weirs, or (4) step-back-water techniques.

Daily mean discharges are computed by averaging the individual discharge measurements using the stage-discharge curves or tables. If the stage-discharge relation is subject to change because of frequent or continual change in the physical features that form the control, the daily mean discharge is determined by the shifting-control method, in which correction factors based on the individual discharge measurements and notes by the personnel making the measurements are applied to the gage heights before the discharges are determined from the curves or tables. This shifting-control method also is used if the stage-discharge relation is changed temporarily because of aquatic vegetation growth or debris on the control. For some gaging stations, formation of ice in the winter can obscure the stage-discharge relations so that daily mean discharges need to be estimated from other information, such as temperature and precipitation records, notes of observations, and records for other gaging stations in the same or nearby basins for comparable periods.

For most gaging stations, there may be periods when no gage-height record is obtained or the recorded gage height is faulty so that it cannot be used to compute daily mean discharge or contents. This record loss occurs when recording instruments malfunction or otherwise fail to operate properly, intakes are plugged, the stilling well is frozen, or various other reasons. For such periods, the daily discharges are estimated from the recorded range in stage, previous or following record, discharge measurements, climatological records, and comparison with other gaging-station records from the same or nearby basins. Information explaining how estimated daily

[7] Routing diagrams reflect Site land configuration at the start of WY04.

[8] Stage is the water level (in units such as feet or meters) in a conveyance structure.

discharge values are identified in gaging-station records is provided in the "Identifying Estimated Daily Discharge" section below.

3.1.2 Data Presentation

The information published for each continuous-record surface-water gaging station consists of six parts: the station description; a map showing the drainage area for the station; a plot of the daily mean discharge for the water year(s); a table of daily mean discharge values for the water year with summary data; a tabular statistical summary of monthly mean discharge data for the water year; and a summary statistics table that includes statistical data of annual discharge and runoff. The tables are included in Appendix A: Hydrologic Data, while the other information is presented below.

3.1.3 Station Description

The station description provides, under various headings, descriptive information included gaging-station location, drainage area, period of record, and gage information. The following information is provided:

LOCATION - This entry provides the gaging-station state plane coordinates and geographic location. Gaging station state plane coordinates were obtained by geographic positioning system (GPS) or digitized from RFETS geographic information system (GIS) coverages.

DRAINAGE AREA - This entry provides the drainage area (in acres) of the gaged basin. If, because of unusual natural conditions or artificial controls, some part of the basin does not contribute flow to the total flow measured at the gage, the noncontributing drainage area also is identified. Drainage area is usually measured using digital techniques and the most accurate maps available. Because the type of map available might vary from one drainage basin to another, the accuracy of digitized drainage areas also can vary. Drainage areas are updated as better maps become available. Some of the gaging stations included in this report measure stage and discharge in channels that convey water to or from reservoirs or other features; these channels might have little or no contributing drainage area. Drainage areas in this report were provided by RFETS GIS coverages.[9]

PERIOD OF RECORD - This entry provides the period for which the Site has been collecting records at the gage. This entry includes the month and year of the start of collection of hydrologic records by the Site and the words "to current year" if the records are to be continued into the following year.

GAGE - This entry provides the type of gage currently in use, and a condensed history of the types and locations of previous gages.

3.1.4 Daily Mean Discharge Values

The daily mean discharge values computed for each gaging station during a water year are listed in the body of the data tables in Appendix A. In the monthly "FLOW RATE" summary part of the table, the line headed "AVERAGE" lists the average discharge, in cubic feet per second, during the month; and the lines headed "MAXIMUM" and "MINIMUM" list the maximum and minimum daily mean discharges for each month. Total discharge for the month also is expressed in cubic feet ("CUBIC FEET"), gallons ("GALLONS"), and acre-feet ("ACRE-FEET"). The term "PARTIAL DATA" denotes a month with incomplete data.

3.1.5 Summary Statistics

A section of the table titled ANNUAL SUMMARIES FOR WY05 follows the monthly mean data section. This section provides a statistical summary of annual discharge flow rates and volumes for the labeled water year. The applicable units are to the left of the table value. The term "PARTIAL DATA" denotes a year with incomplete data.

[9] Drainage area maps show Site configuration at the start of WY04.

3.1.6 Identifying Estimated Daily Discharge

Estimated daily discharges published in water-discharge tables and figures of this annual report are identified by *italicizing* individual daily values or through color coding in hydrographs. For periods of no data, a gap is shown on the hydrographs.

3.1.7 Other Records Available

Information used in the preparation of the records in this report, such as discharge-measurement notes, gage-height records, and rating tables, are on file. Information on the availability of the unpublished information or on the published statistical analyses is available from personnel involved with data collection at the Site.

Figure 3-1. RFETS Buffer Zone Water Routing Schematic: Start of WY05 (Map Insert).

Figure 3-2. RFETS Industrial Area Water Routing Schematic: Start of WY05 (Map Insert).

Figure 3-3. RFETS Water Routing Schematic: End of WY05 (Map Insert).

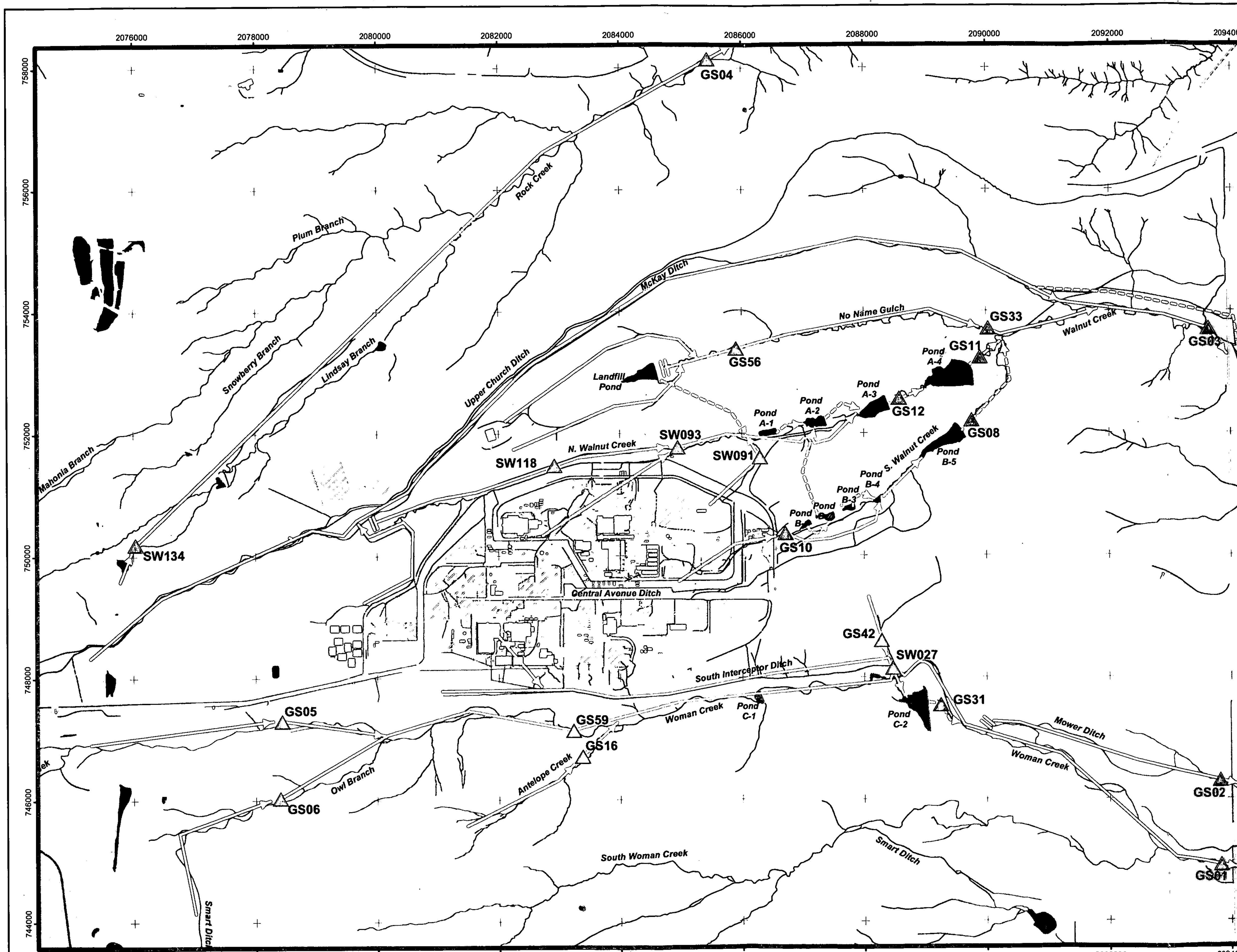

Figure 3-1

RFETS Buffer Zone Water Routing Schematic: Start of WY05

EXPLANATION

- Automated Monitoring Location
- Normal Uncontrolled Runoff Pathway
- Normal Controlled Flow Pathway

NOTES:

The monitoring locations, flow, and runoff pathways on this map are approximate and, as such, are not intended to accurately portray the true locations of these features. This schematic has been modified to clearly identify the relationships between the surface water map features.

Standard Map Features

- Buildings and other structures
- Demolished buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Paved roads
- Rocky Flats Environmental Technology Site boundary

DATA SOURCE BASE FEATURES:

Buildings, fences, hydrography, roads, and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

0 800 1,600 2,400 3,200 Feet

Scale 1:19,200

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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November 15, 2005

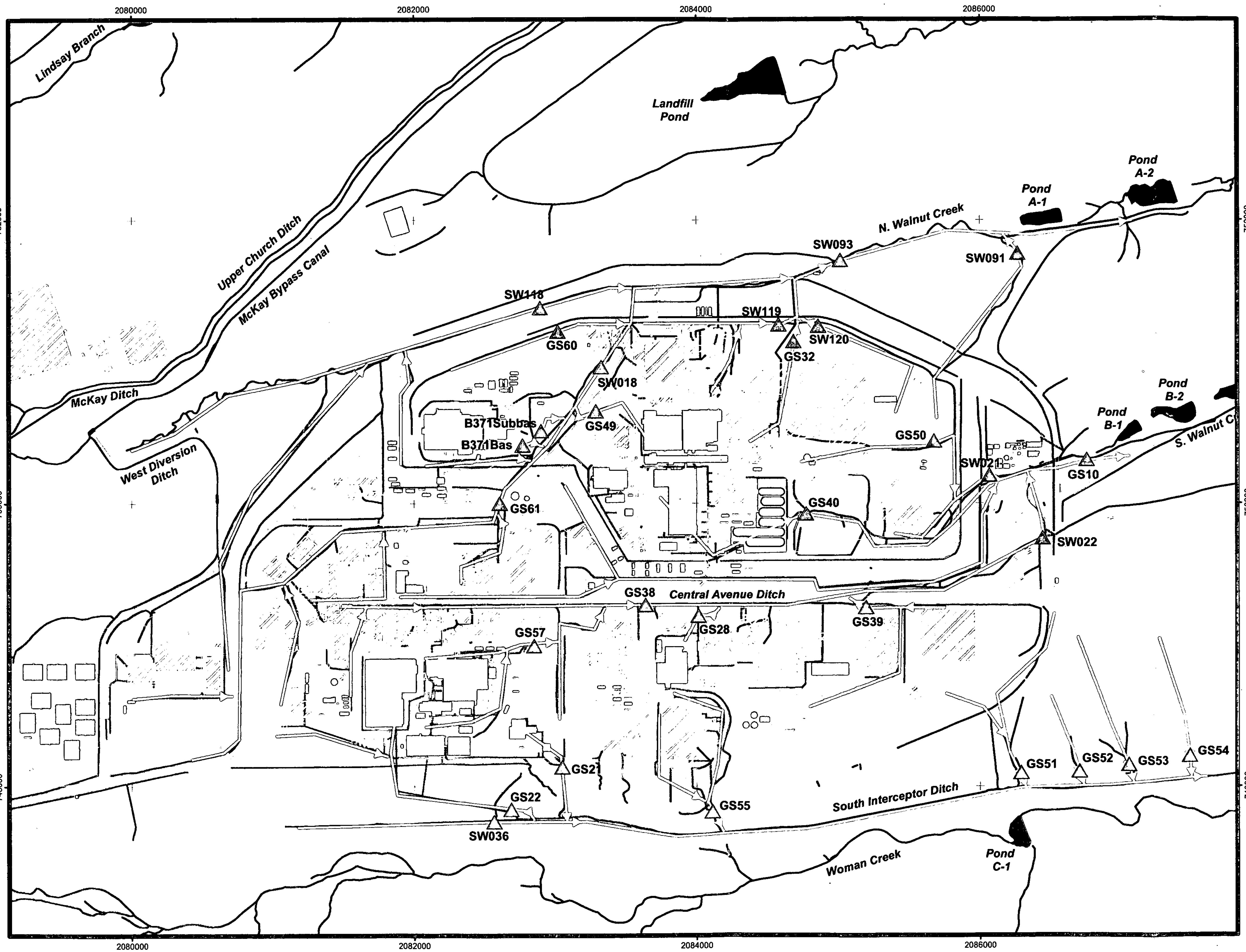

Figure 3-2

RFETS Industrial Area Water Routing Schematic: Start of WY05

EXPLANATION

- Automated Monitoring Station
- Normal Uncontrolled Runoff Pathway
- Normal Controlled Flow Pathway

NOTES:

The monitoring locations, flow, and runoff pathways on this map are approximate and, as such, are not intended to accurately portray the true locations of these features. This schematic has been modified to clearly identify the relationships between the surface water map features.

Standard Map Features

- Buildings and other structures
- Demolished buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Paved roads
- Rocky Flats Environmental Technology Site boundary

DATA SOURCE BASE FEATURES:

Buildings, fences, hydrography, roads, and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\FY2006\WY05 SW Annual\Fig 3-2.mxd

November 15, 2005

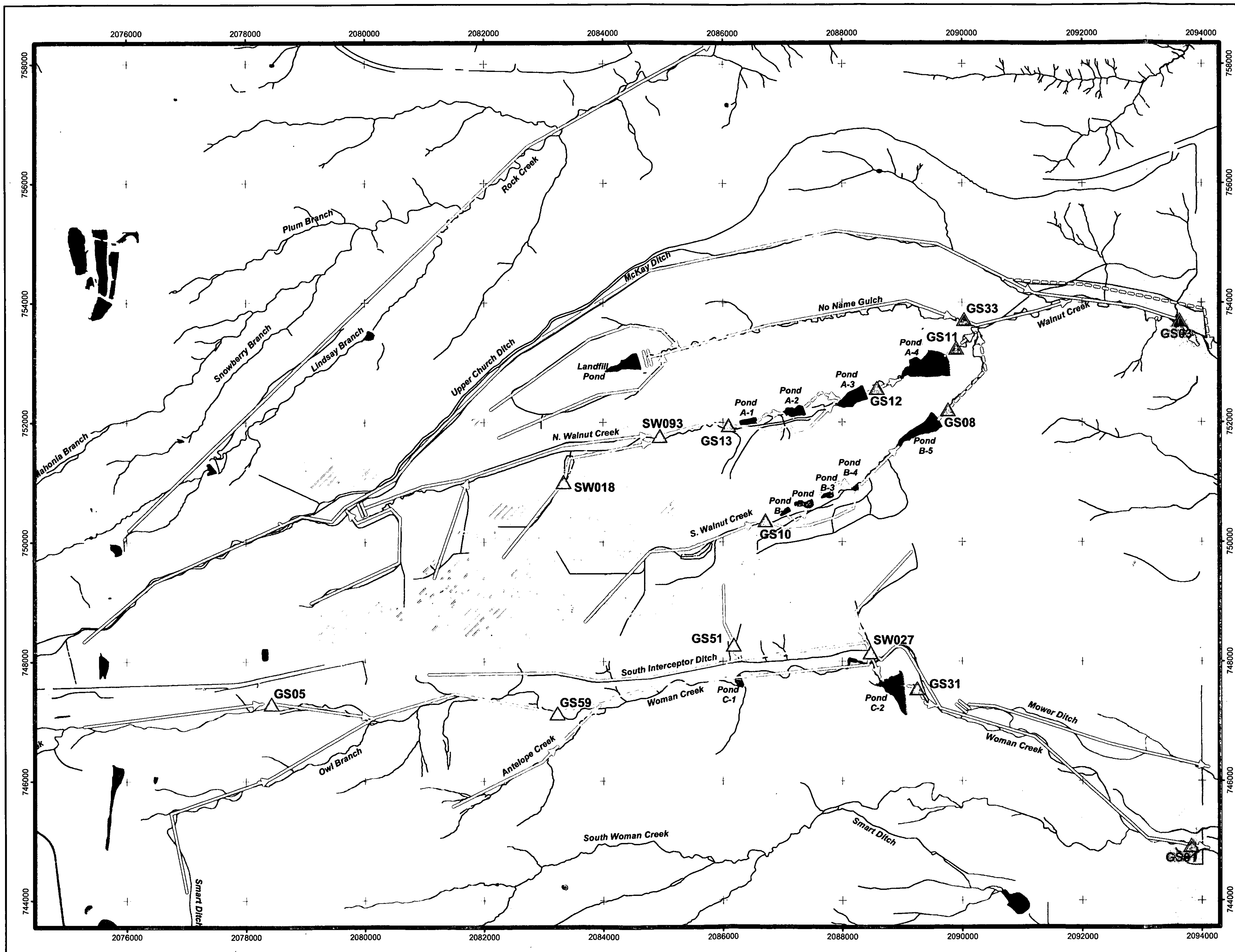

Figure 3-3

RFETS Water Routing Schematic: End of WY05

EXPLANATION

- Automated Monitoring Station
- Normal Uncontrolled Runoff Pathway
- Normal Controlled Flow Pathway

NOTES:

The monitoring locations, flow, and runoff pathways on this map are approximate and, as such, are not intended to accurately portray the true locations of these features. This schematic has been modified to clearly identify the relationships between the surface water map features.

Standard Map Features

- Demolished buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Paved roads
- Rocky Flats Environmental Technology Site boundary

DATA SOURCE BASE FEATURES:

Buildings, fences, hydrography, roads, and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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3.2 DISCHARGE DATA SUMMARIES

3.2.1 Site-Wide Discharge Summary

Discharge summaries for the three major Site drainage areas (Walnut, Woman, and Rock Creeks) are given in Figure 3-4 and Figure 3-5. Walnut Creek flows are measured at GS03, Woman Creek flows are measured at GS01, and Rock Creek flows are measured at GS04. Figure 3-6 shows the relative total WY97-05 discharge volumes from the major Site drainages as measured at GS01, GS03, and GS04.

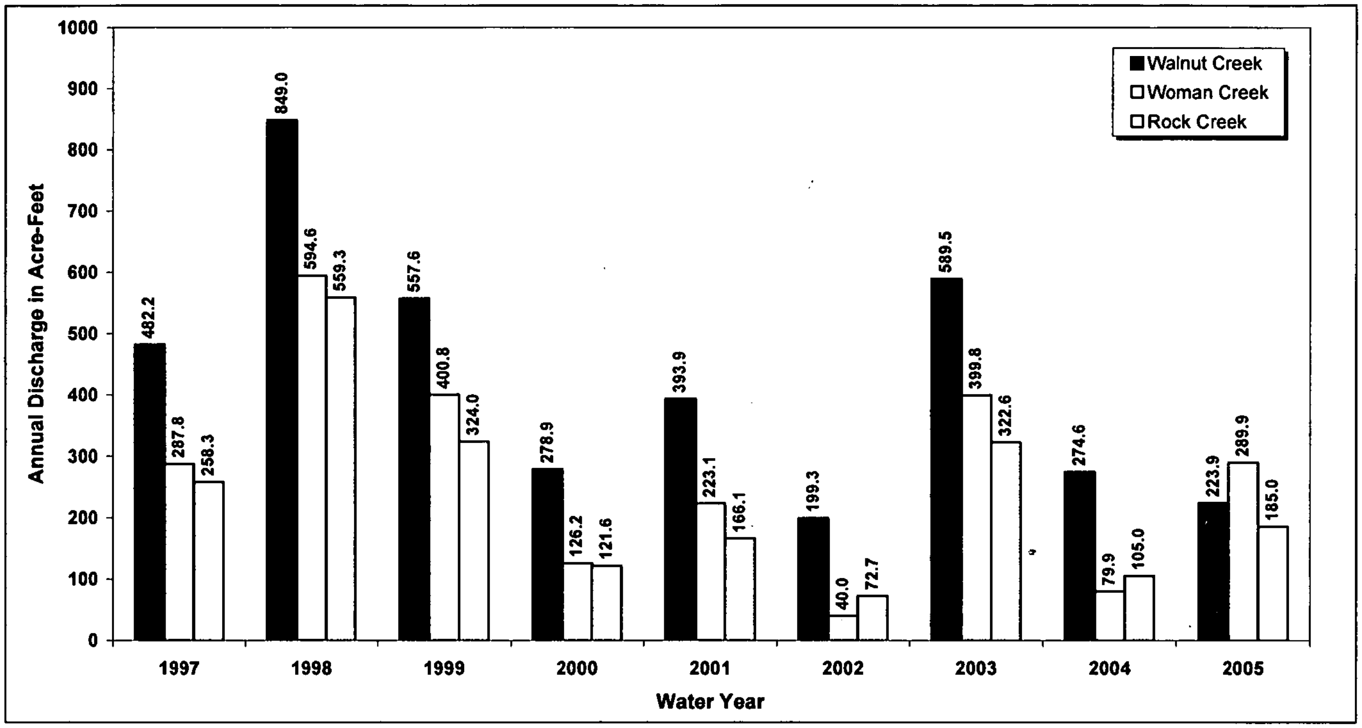


Figure 3-4. Annual Discharge Summary from Major Site Drainages: WY97-05.

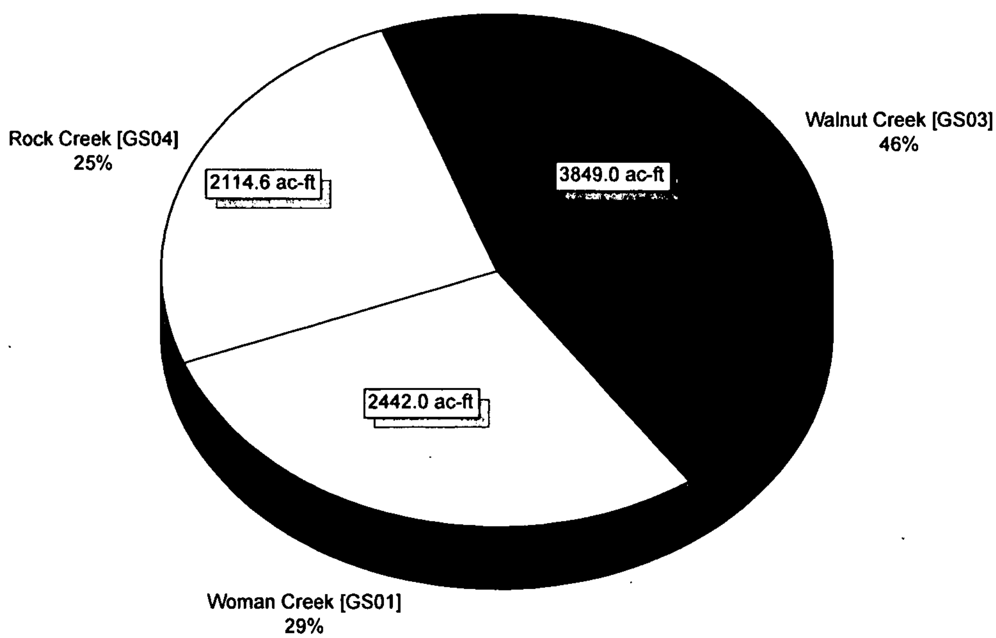


Figure 3-5. Relative Total Discharge Summary from Major Site Drainages: WY97-05.

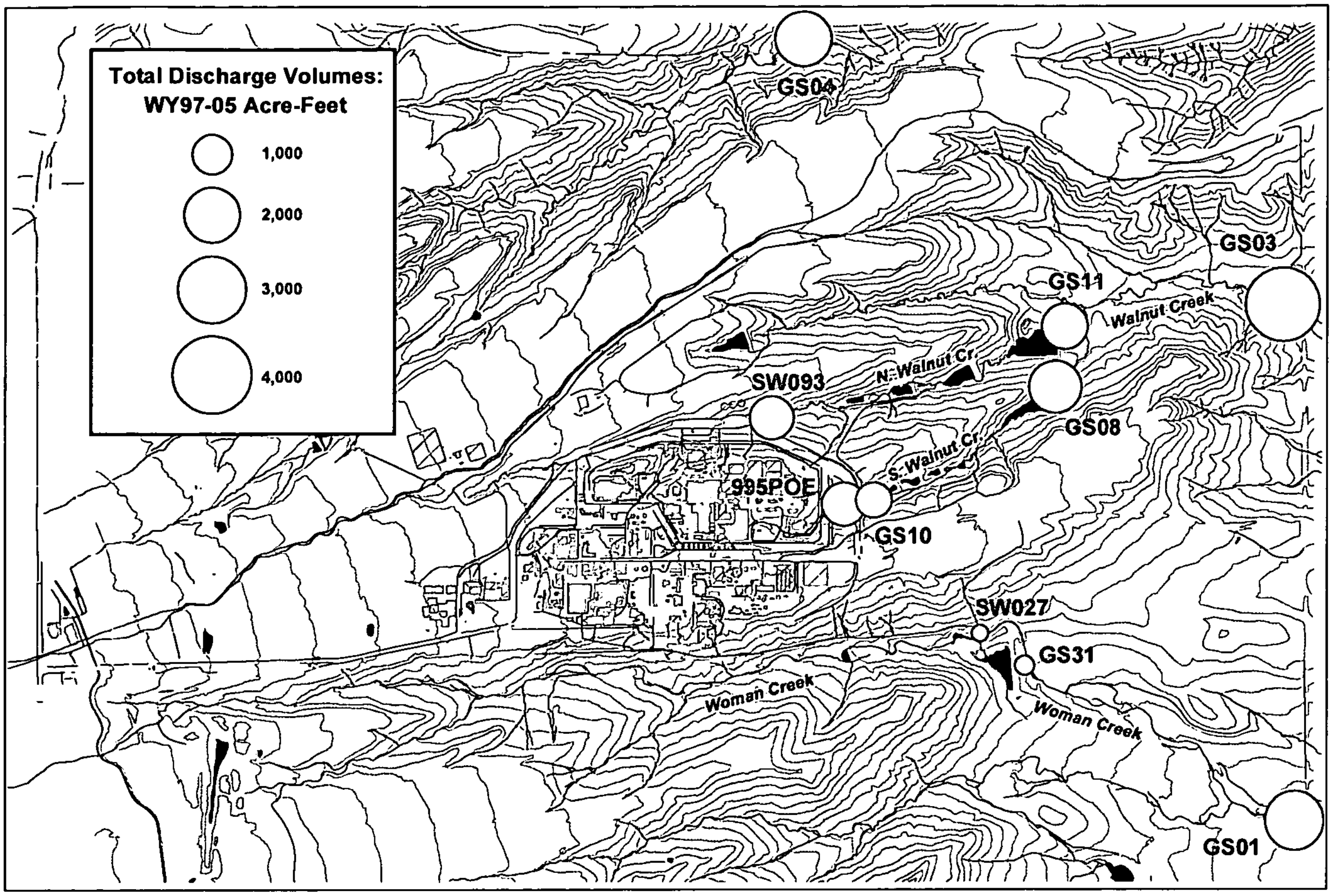
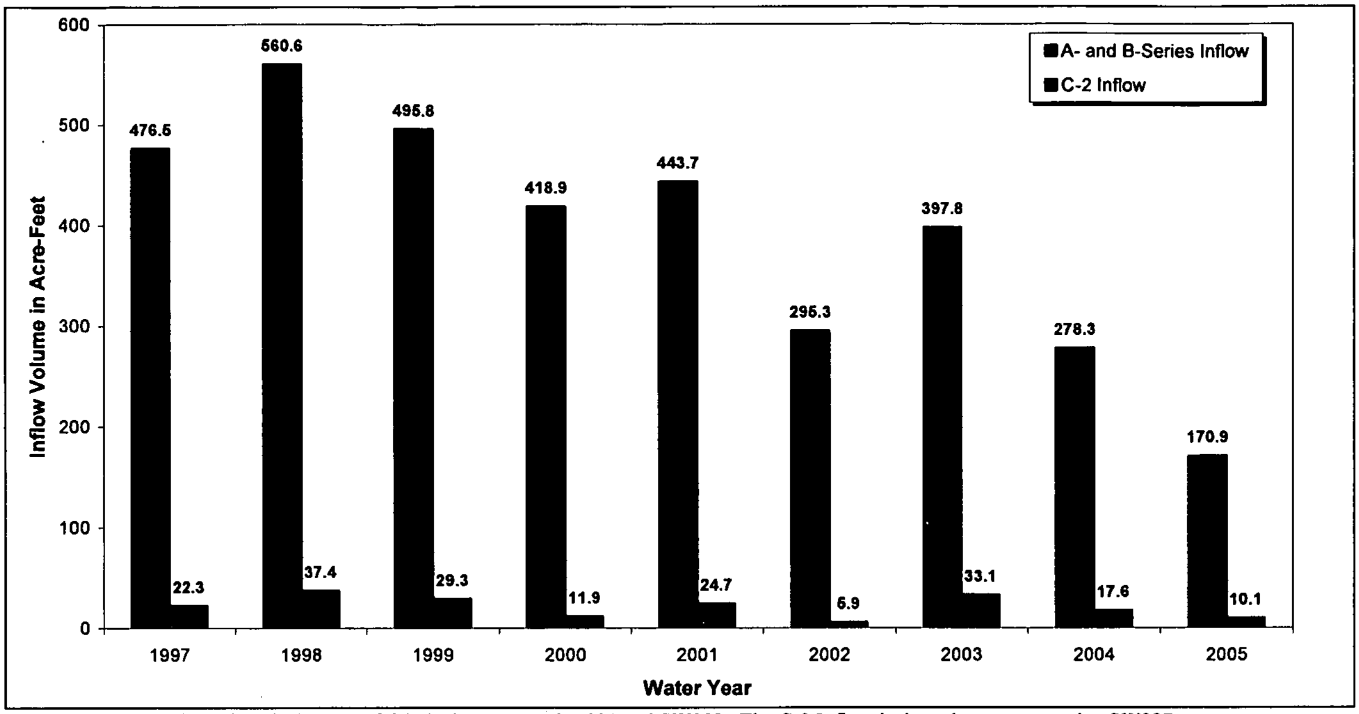


Figure 3-6. Map Showing Relative WY97-05 Discharge Volumes for Selected Gaging Stations.

3.2.2 Retention Ponds Discharge Summary

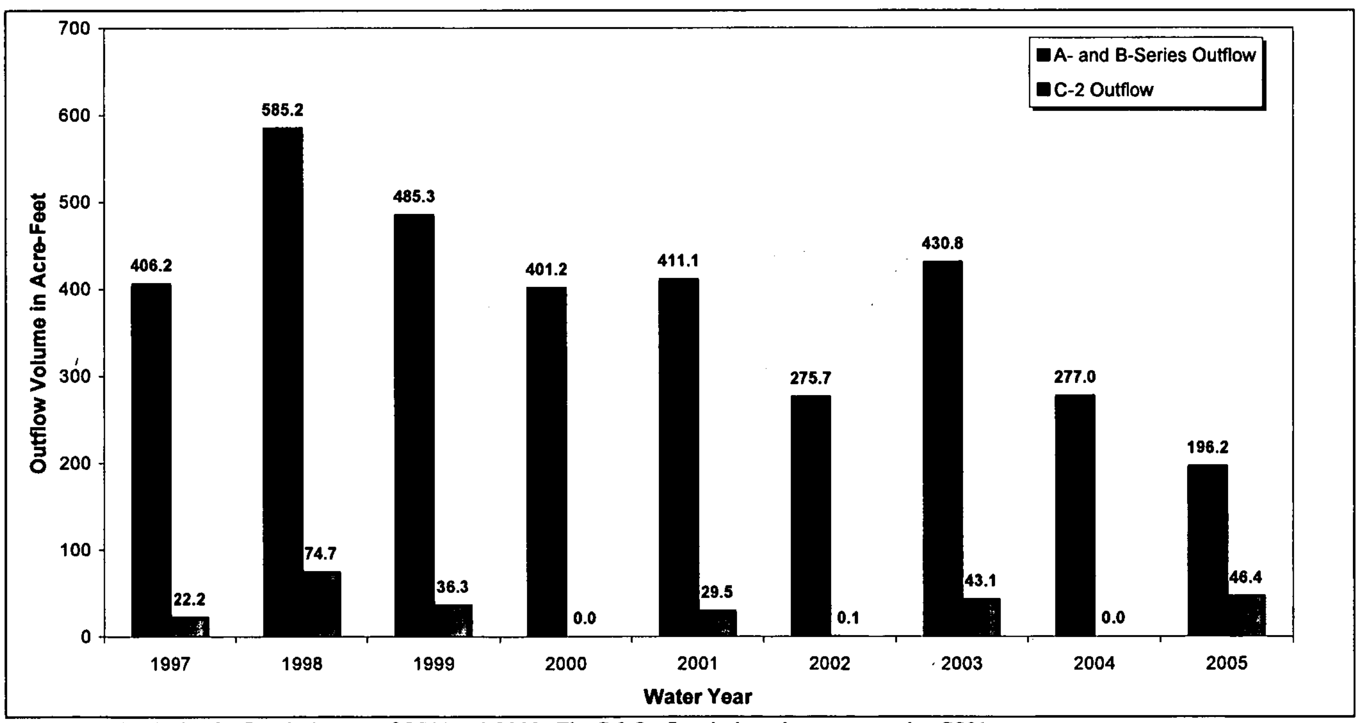
Figure 3-7 and Figure 3-8 show the annual retention ponds inflows and outflows, respectively. Due to the intermittent pump transfers of Pond B-5 water to Pond A-4, the volumes for the A- and B-Series Ponds are combined. Figure 3-9 shows the relative total WY97-05 discharge volumes from the retention ponds (as measured at GS08, GS11, and GS31) and from the major IA drainages to the ponds (as measured at GS10, SW027, SW091, SW093, and the WWTP [995POE])[10]. Pond inflows do not necessarily equal outflows for any given year due to the storage of water in the ponds across water years, evaporative/seepage losses/gains, and local runoff to the ponds.

[10] The WWTP was removed from service on 11/4/04.



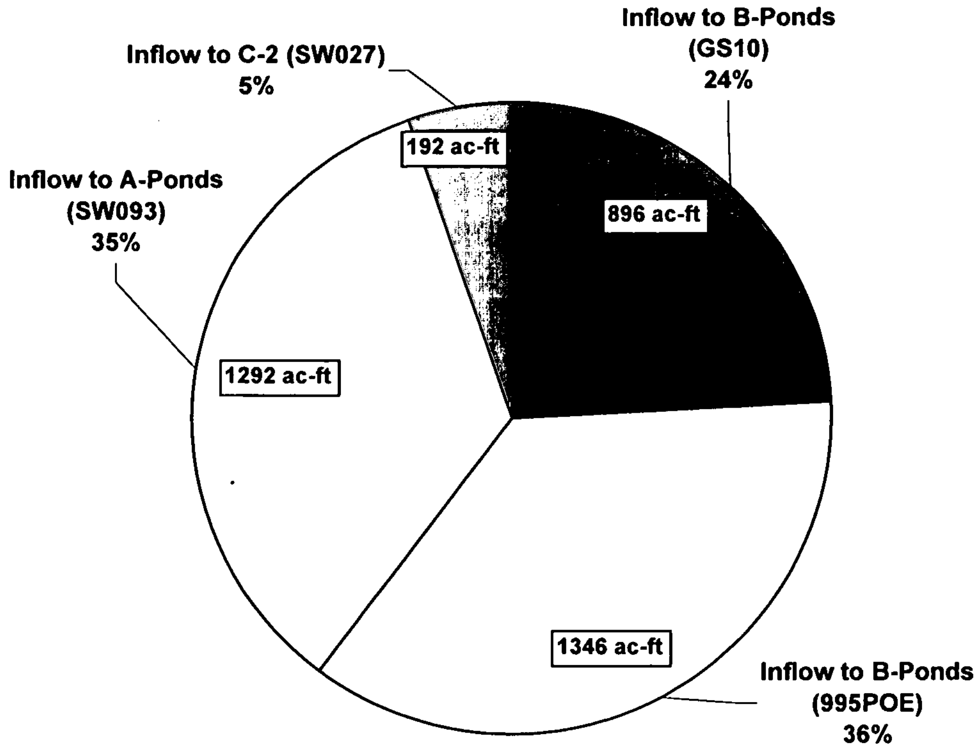
Notes: A- and B-Series Inflow is the sum of GS10, the WWTP, SW091 and SW093. The C-2 Inflow is the volume measured at SW027.

Figure 3-7. Retention Pond Inflows: WY97-05.

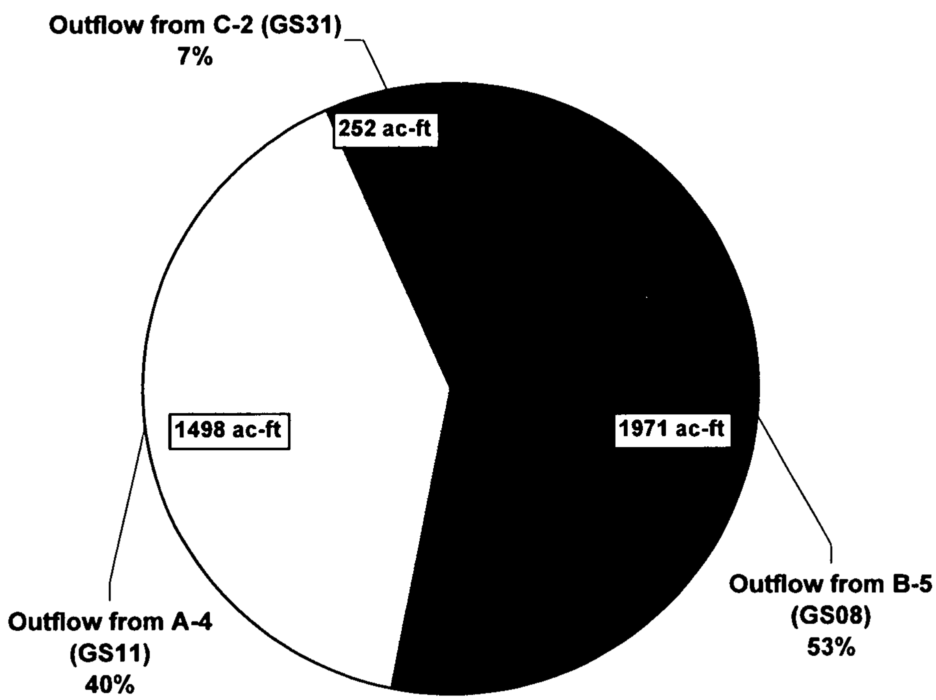


Notes: A- and B-Series Outflow is the sum of GS11 and GS08. The C-2 Outflow is the volume measured at GS31.

Figure 3-8. Retention Pond Outflows: WY97-05.



Pond Inflows



Pond Outflows

Figure 3-9. Relative Total Inflow and Outflow Volumes for RFETS Retention Ponds: WY97-05.

3.2.3 GS01: Woman Creek at Indiana Street

Location

Woman Creek 200' upstream of Indiana Street; State Plane: E2093820, N744894

Drainage Area

- The basin includes the Woman Creek drainage and southern portions of the IA; areas west of Highway 93 also contribute runoff (total drainage acreage undetermined)
- IA Areas tributary to GS01: 900, 800, 600, and 400

Period of Record

9/16/91 to current year

Gage

Water-stage recorder and 18" Parshall flume (flume is located just east of Indiana Street, sampling conducted on Site property); prior to 3/24/98 flow measurement was at the onsite sampling location on 9" Parshall flume

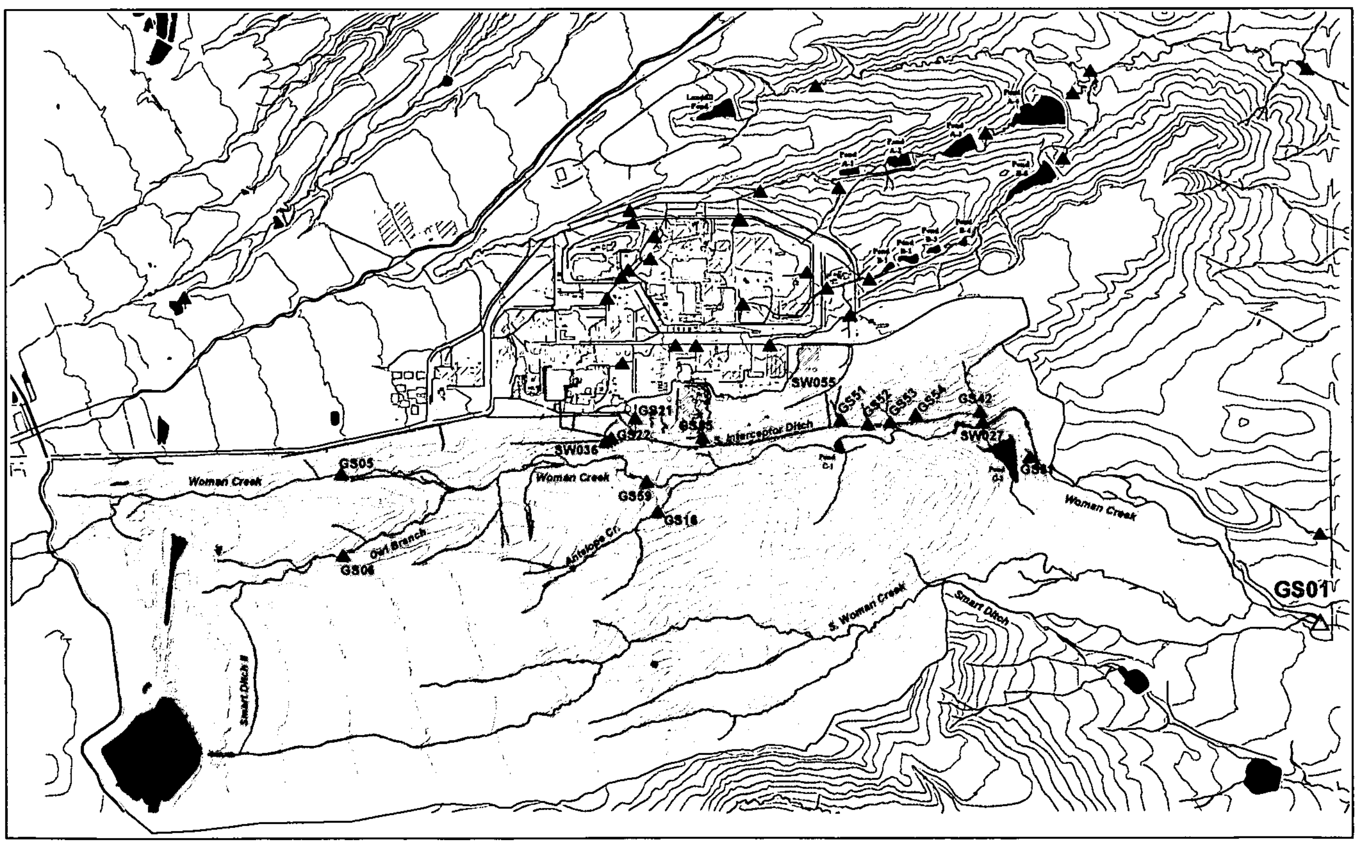


Figure 3-10. Map Showing GS01 Drainage Area.

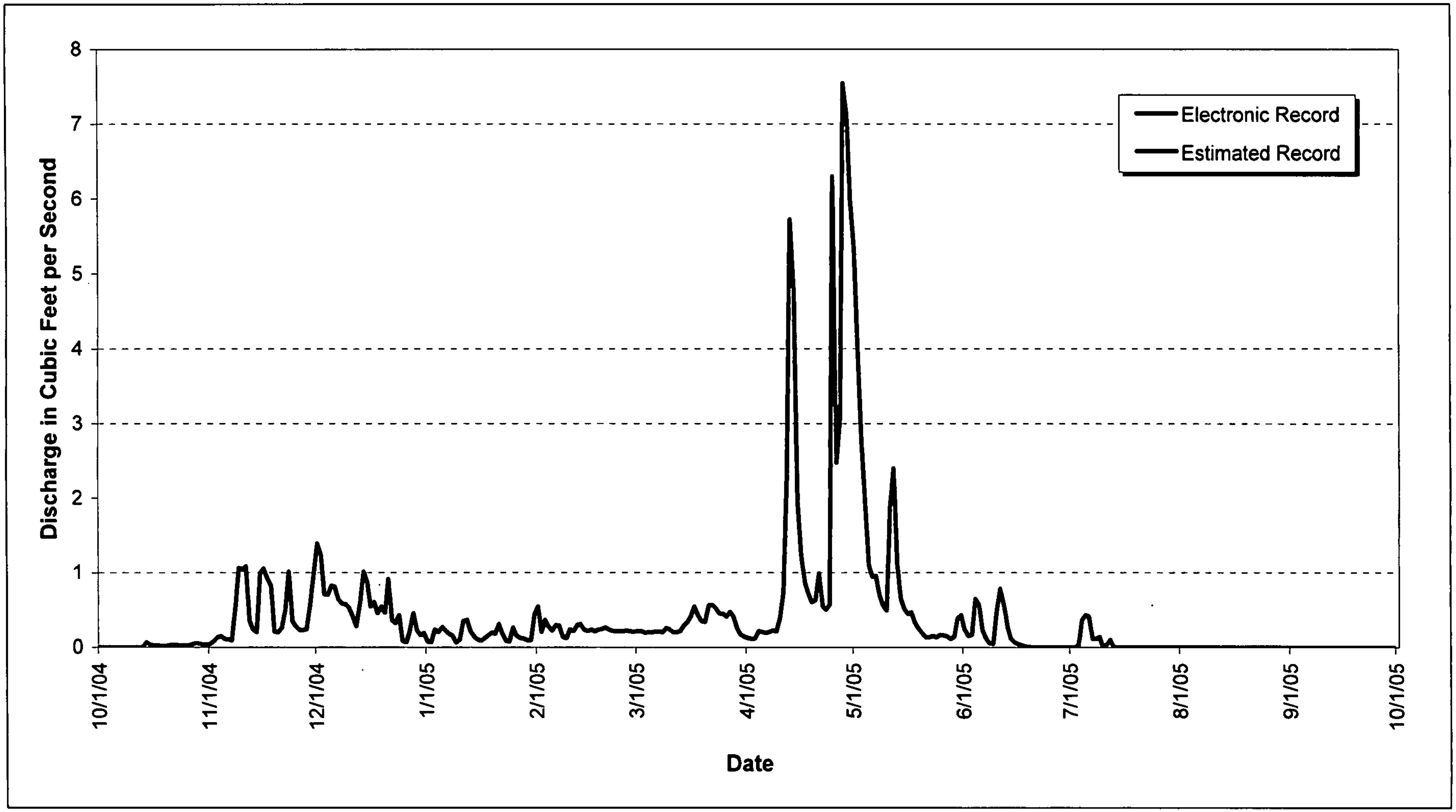


Figure 3-11. WY05 Mean Daily Hydrograph at GS01: Woman Creek at Indiana Street.

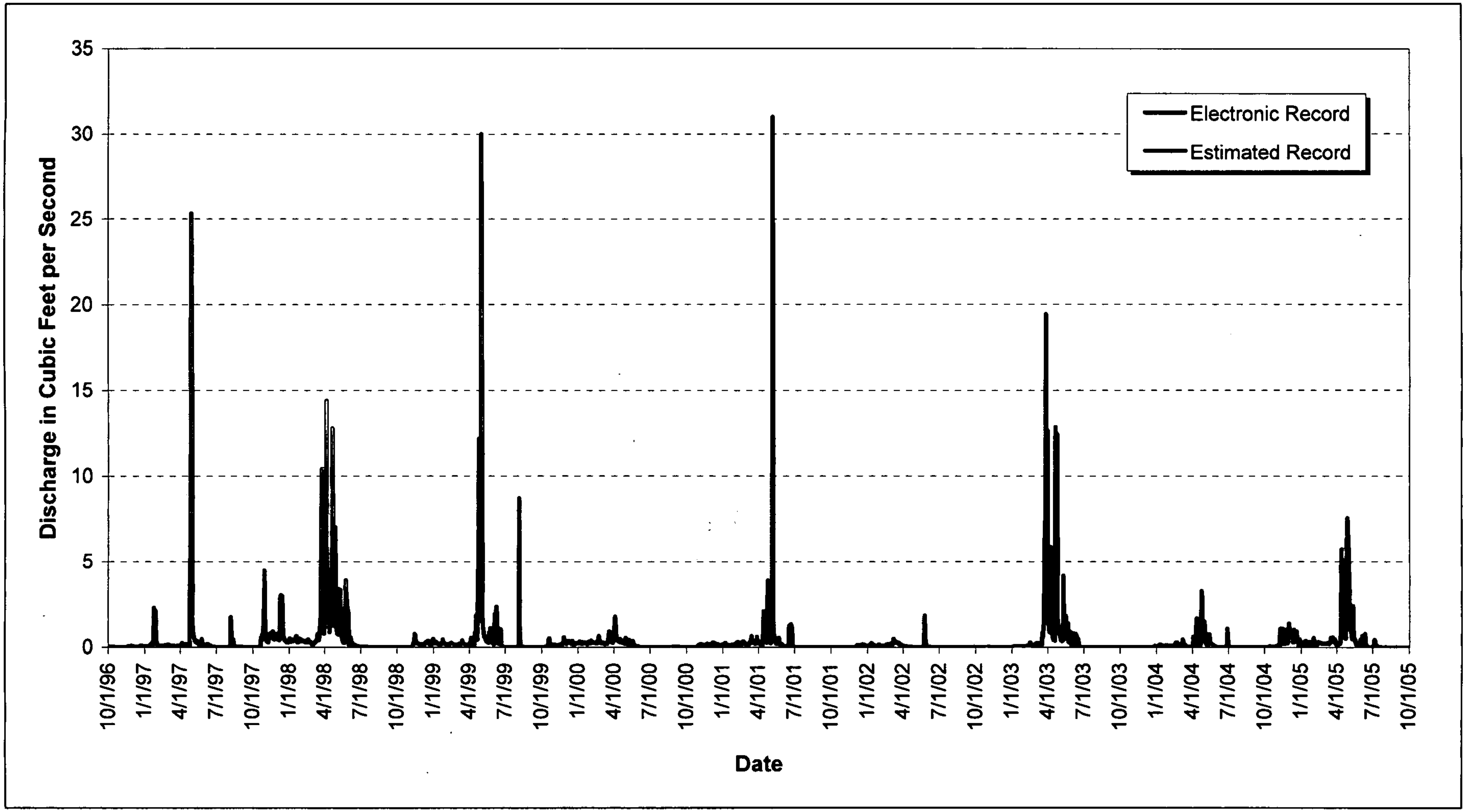


Figure 3-12. WY97-05 Mean Daily Hydrograph at GS01: Woman Creek at Indiana Street.

3.2.4 GS02: Mower Ditch at Indiana Street

Location

Mower Ditch 200' upstream of Indiana Street; State Plane: E2093817, N746302

Drainage Area

- The basin includes areas upgradient of Mower Ditch (total of 157.7 acres)
- IA Areas draining to GS02: none

Period of Record

9/16/91 to 9/7/05 (removed from service)

Gage

Water-stage recorder and 9" Parshall flume; weir insert installed 3/8/99

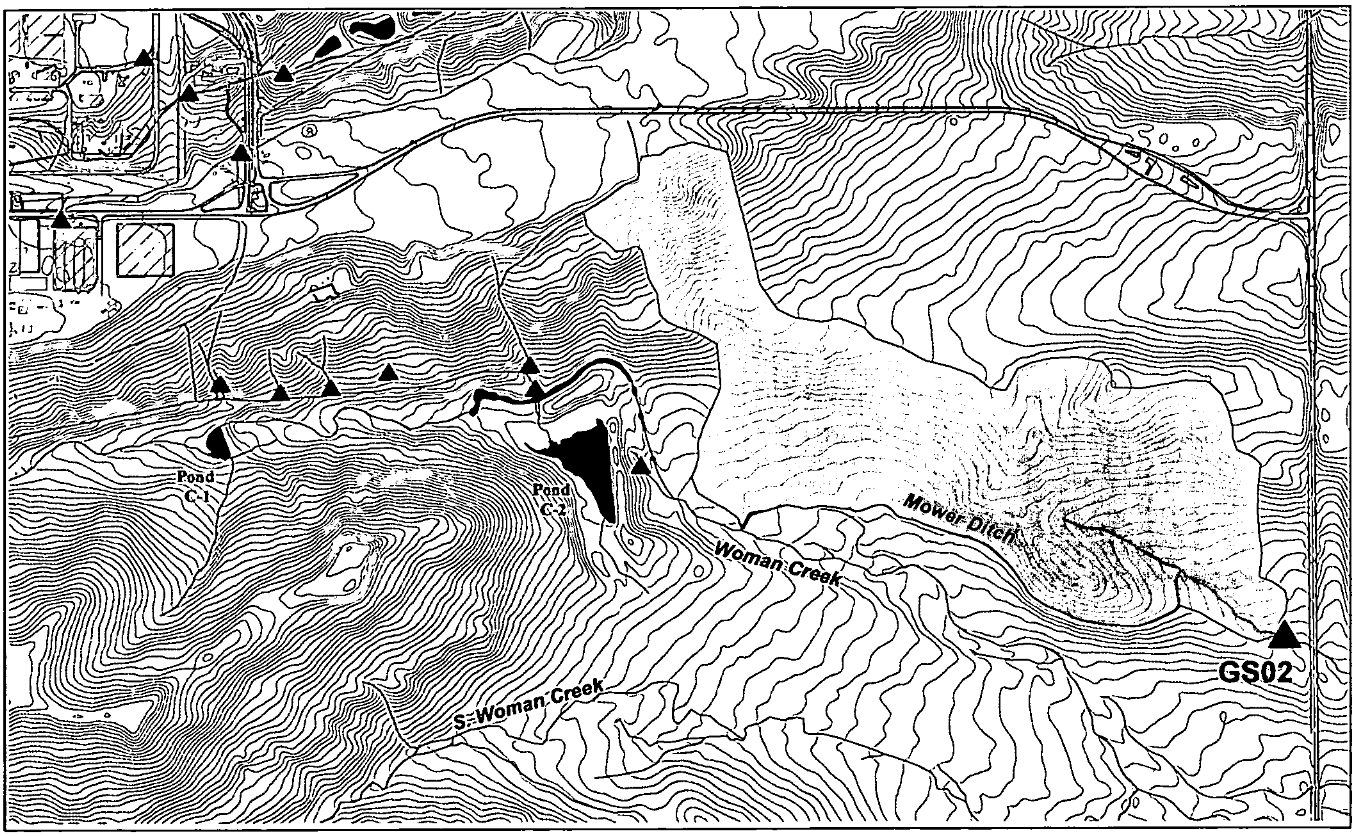


Figure 3-13. Map Showing GS02 Drainage Area.

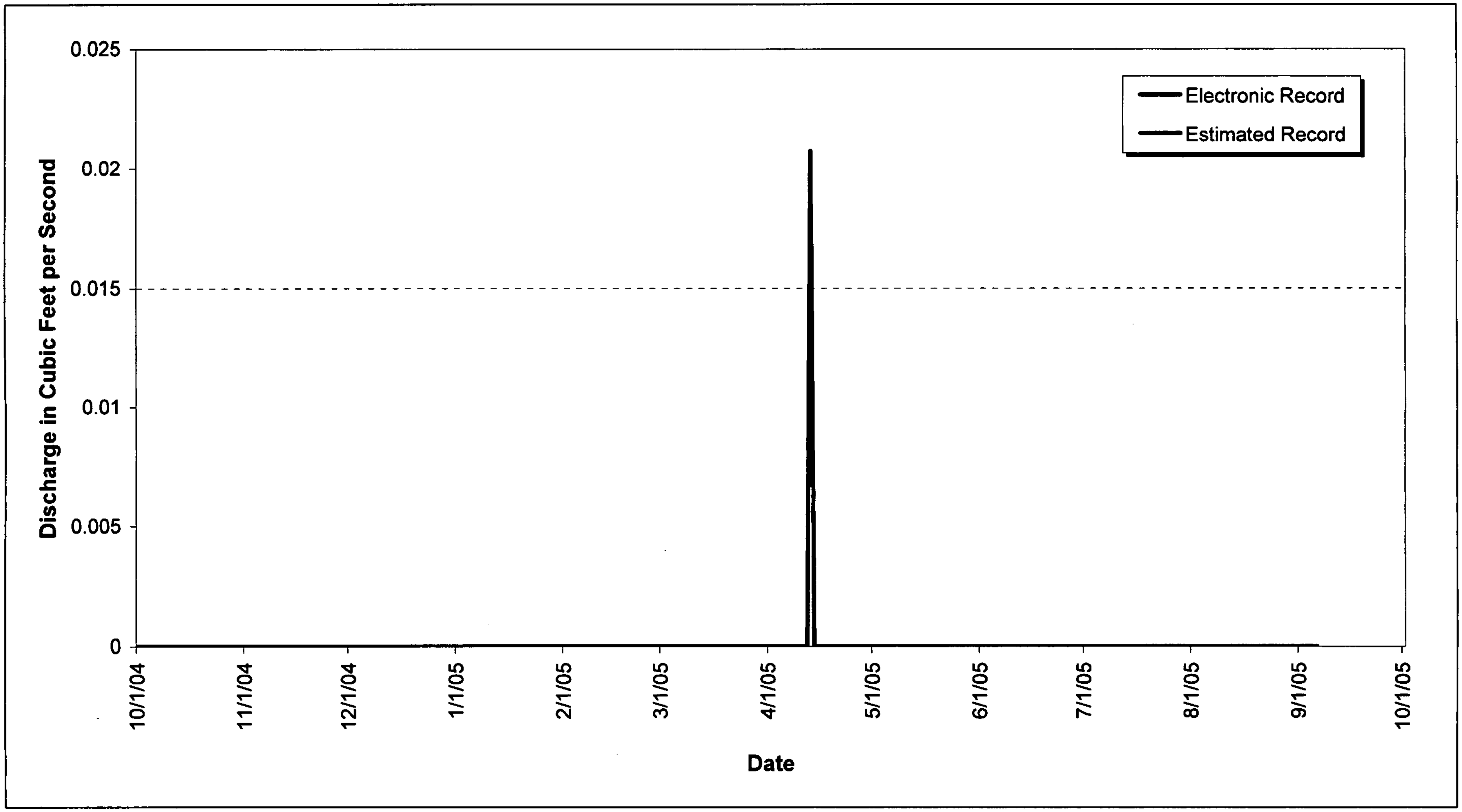


Figure 3-14. WY05 Mean Daily Hydrograph at GS02: Mower Ditch at Indiana Street.

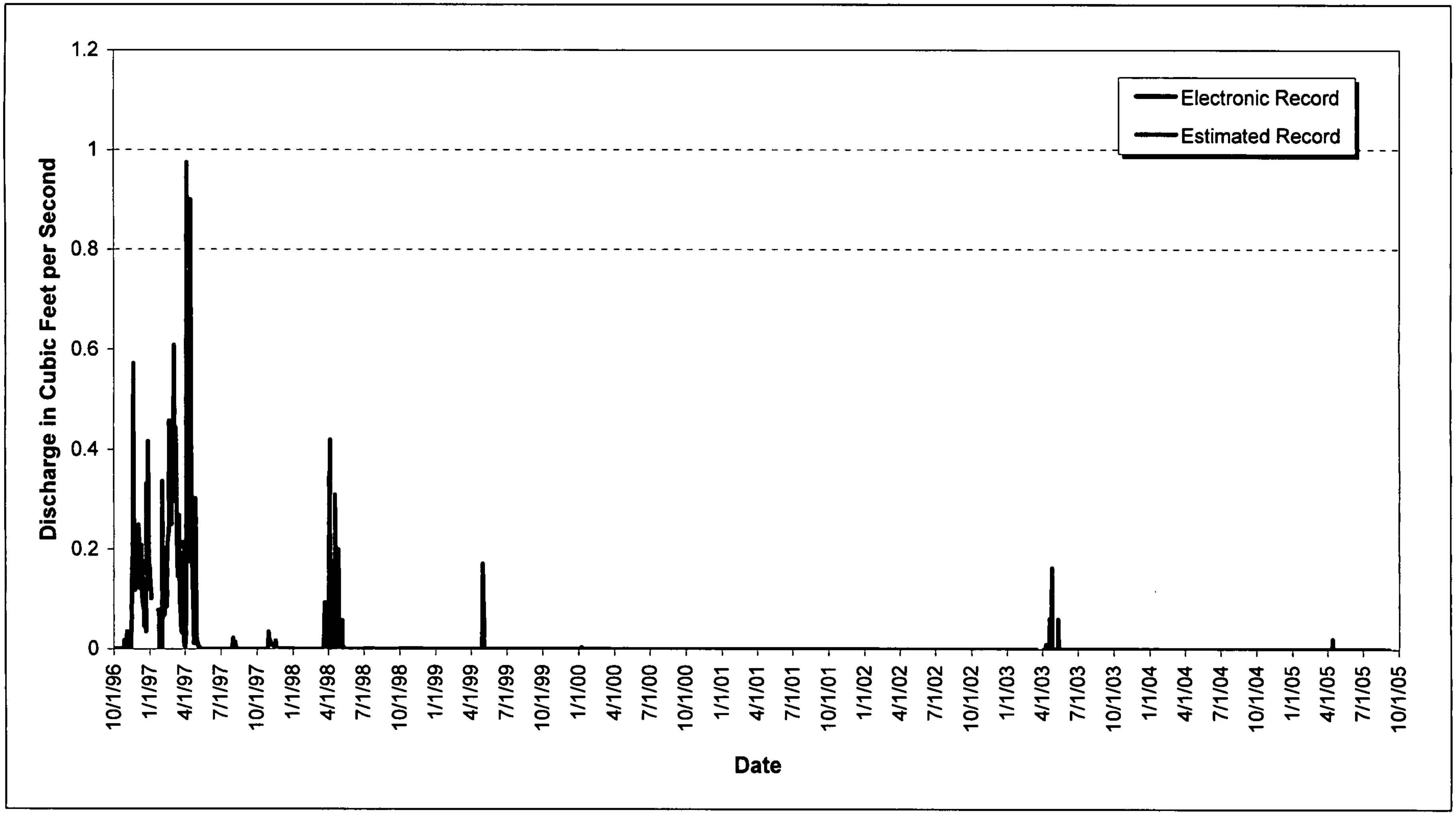


Figure 3-15. WY97-05 Mean Daily Hydrograph at GS02: Mower Ditch at Indiana Street.

3.2.5 GS03: Walnut Creek at Indiana Street

Location

Walnut Creek at Flume Pond outlet upstream of Indiana Street; State Plane: E2093606, N753652

Drainage Area

- The basin includes the Walnut Creek drainage and the majority of the IA; areas west of Highway 93 also contribute runoff (total drainage acreage undetermined)
- IA Areas draining to GS03: all Areas

Period of Record

9/2/91 to current year

Gage

Water-stage recorder and parallel 6" and 36" Parshall flumes prior to 11/5/02. Rated stream section during flume construction (GS03T; 11/5/02-2/12/03). Three-foot HL flume starting 2/12/03.

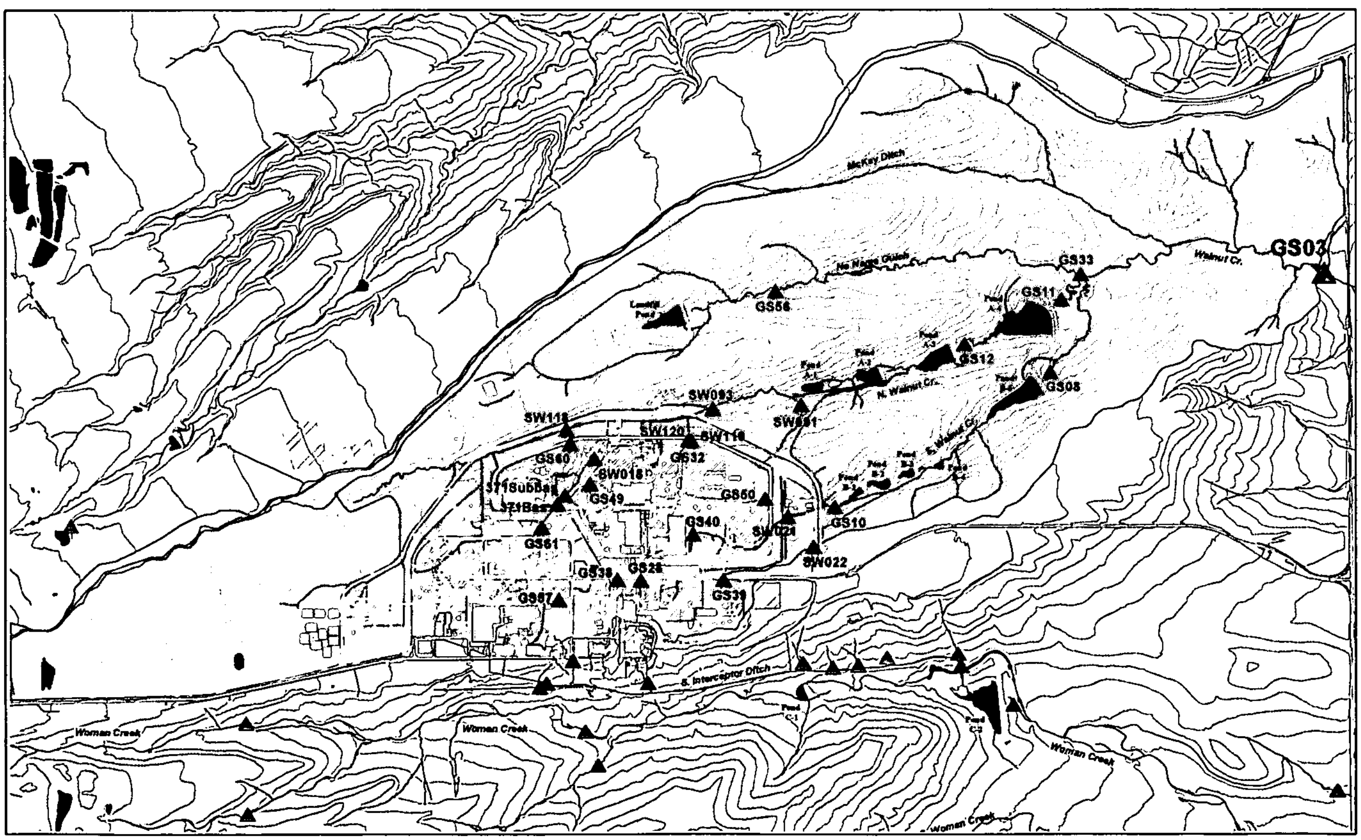


Figure 3-16. Map Showing GS03 Drainage Area.

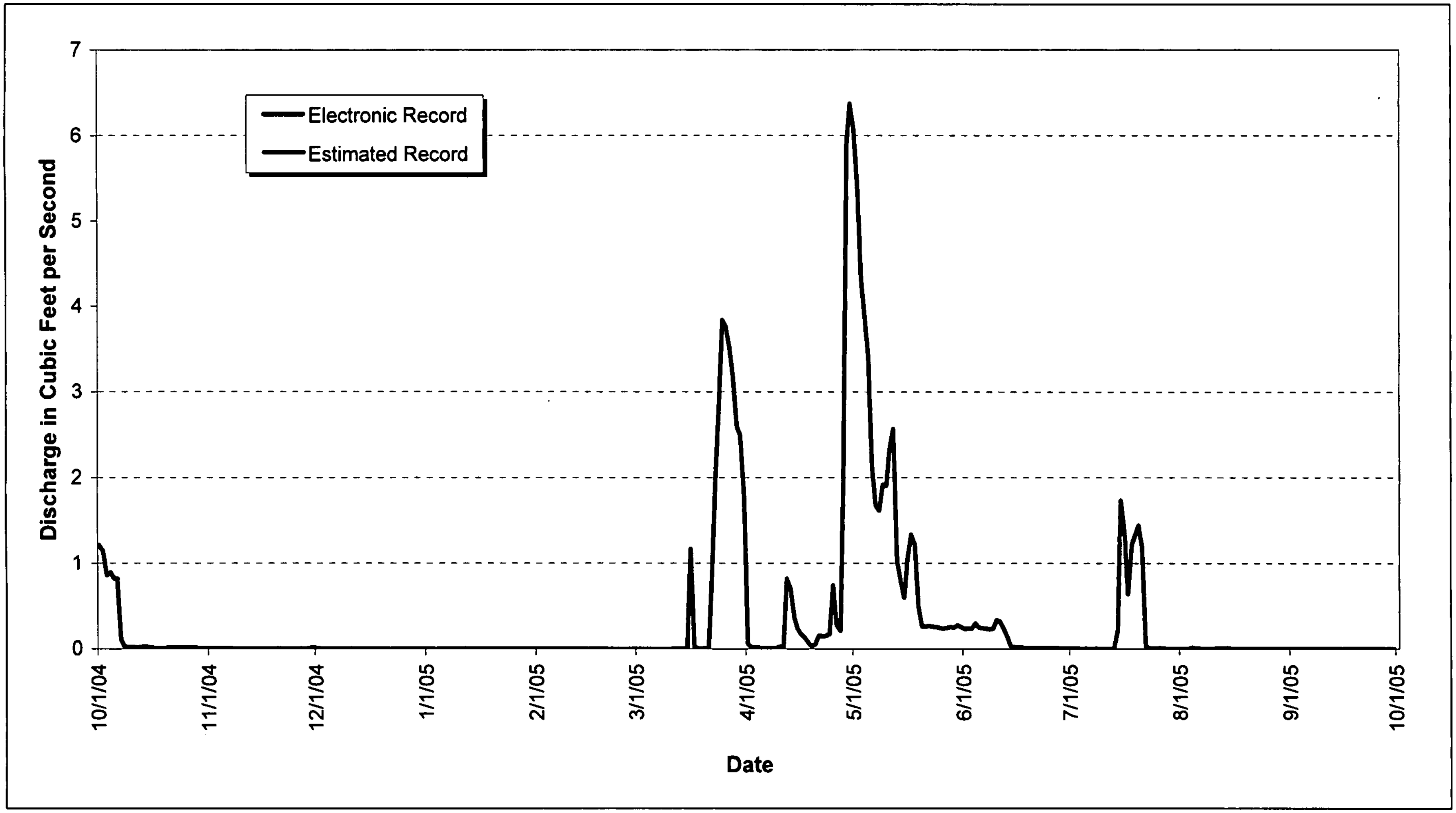


Figure 3-17. WY05 Mean Daily Hydrograph at GS03: Walnut Creek at Indiana Street.

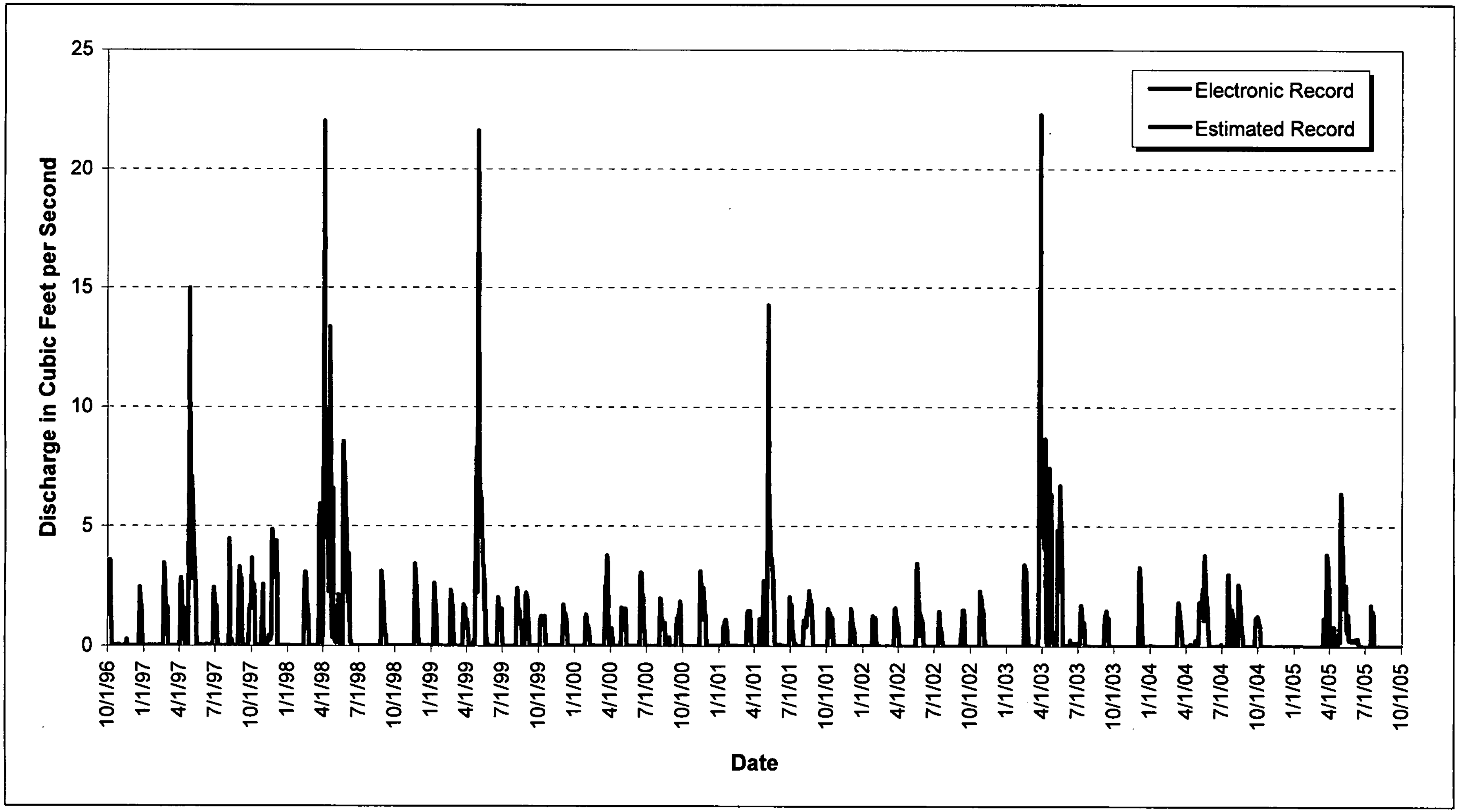


Figure 3-18. WY97-05 Mean Daily Hydrograph at GS03: Walnut Creek at Indiana Street.

3.2.6 GS04: Rock Creek at Highway 128

Location

Rock Creek 200' upstream of box culvert under Route 128; State Plane: E2085552, N758149

Drainage Area

- The basin includes the Rock Creek basin; total drainage acreage undetermined
- IA Areas draining to GS04: none

Period of Record

9/27/91 to 9/30/05 (removed from service)

Gage

Water-stage recorder and 9" Parshall flume; weir insert installed 3/4/99

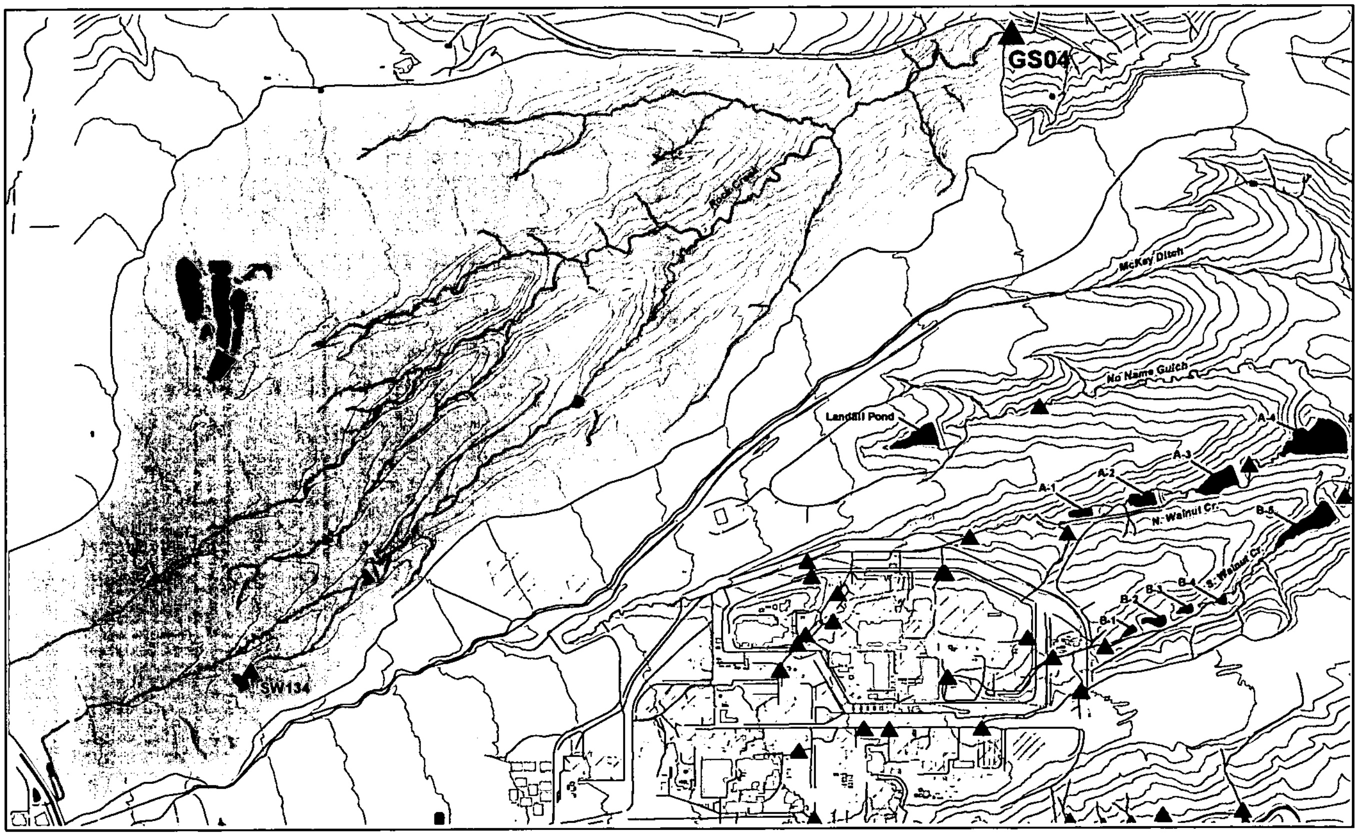


Figure 3-19. Map Showing GS04 Drainage Area.

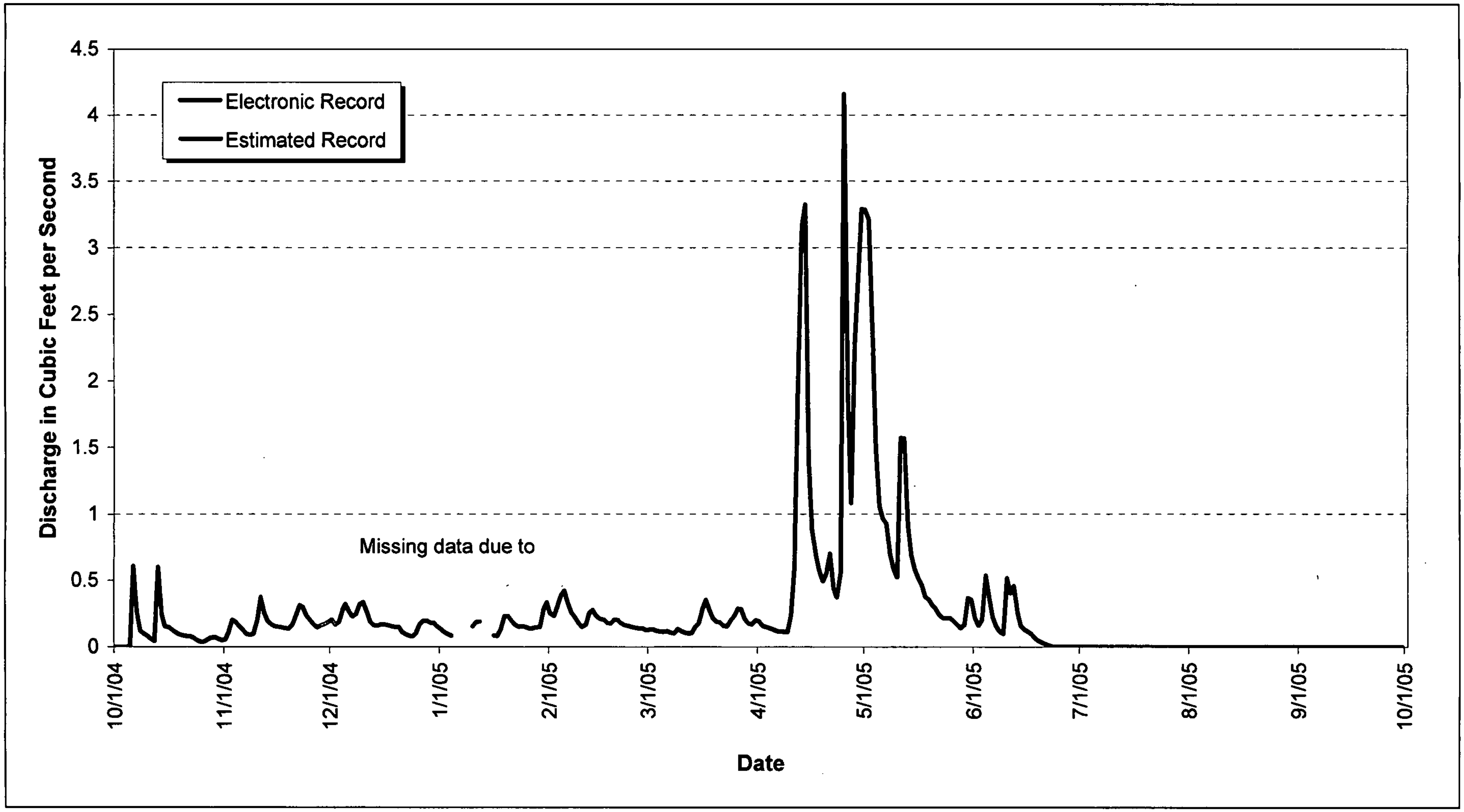


Figure 3-20. WY05 Mean Daily Hydrograph at GS04: Rock Creek at Highway 128.

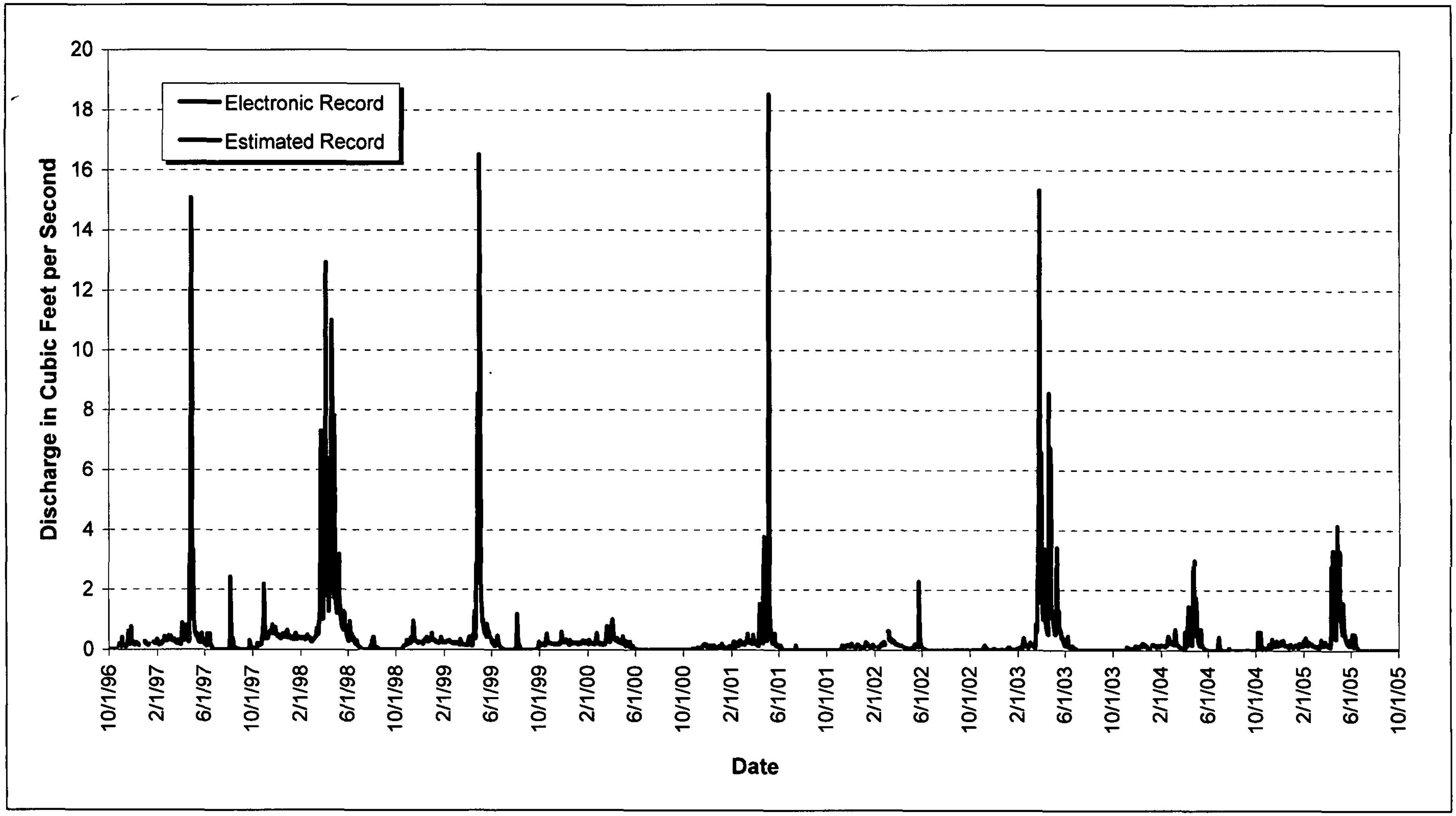


Figure 3-21. WY97-05 Mean Daily Hydrograph at GS04: Rock Creek at Highway 128.

3.2.7 GS05: Woman Creek at West Fenceline

Location

Woman Creek east of west Site boundary; State Plane: E2078428, N747260

Drainage Area

- The basin includes a portion of the Woman Creek drainage; areas west of Highway 93 also contribute runoff (total drainage acreage undetermined)
- IA Areas draining to GS05: none

Period of Record

9/23/91 to current year

Gage

Water-stage recorder and 9" Parshall flume

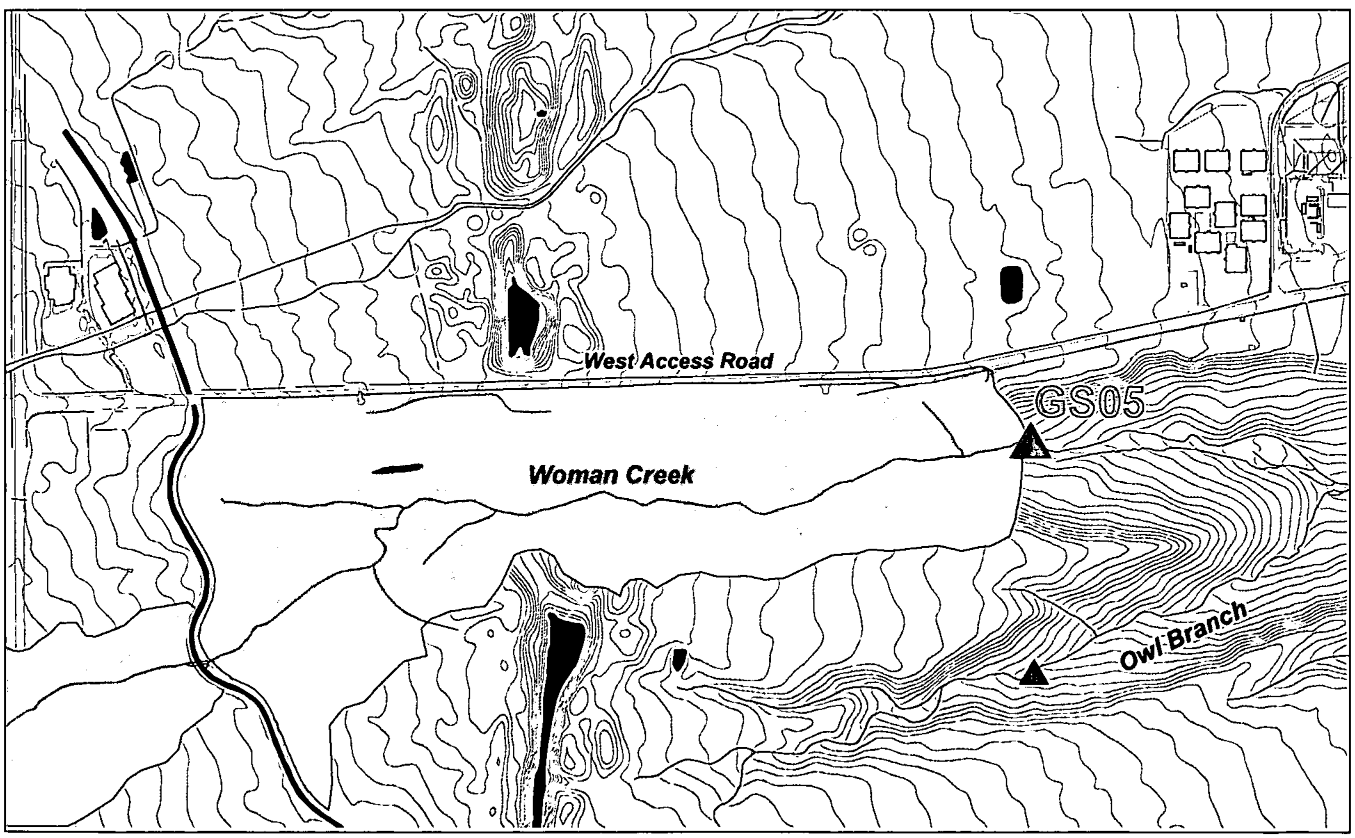


Figure 3-22. Map Showing GS05 Drainage Area.

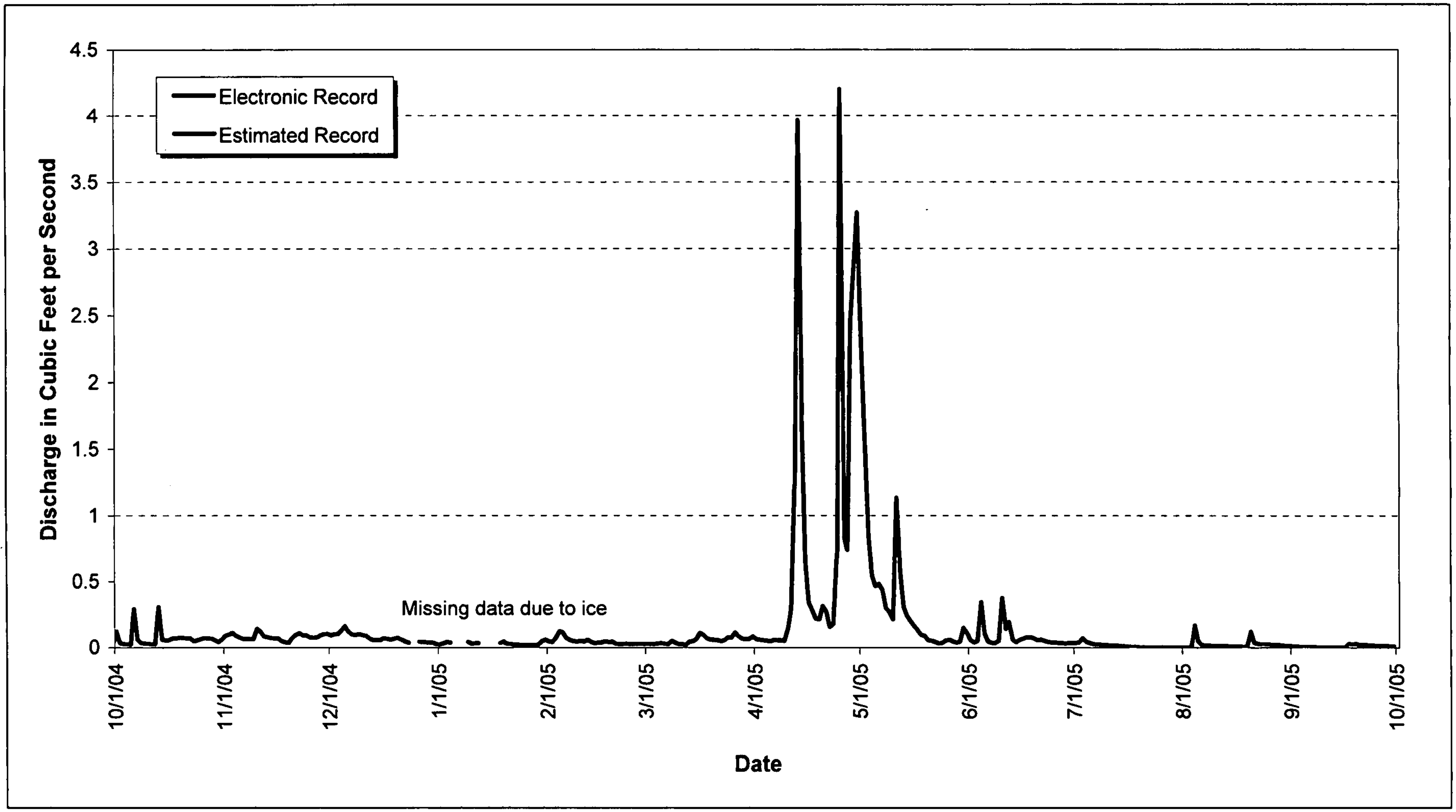


Figure 3-23. WY05 Mean Daily Hydrograph at GS05: North Woman Creek at West Fenceline.

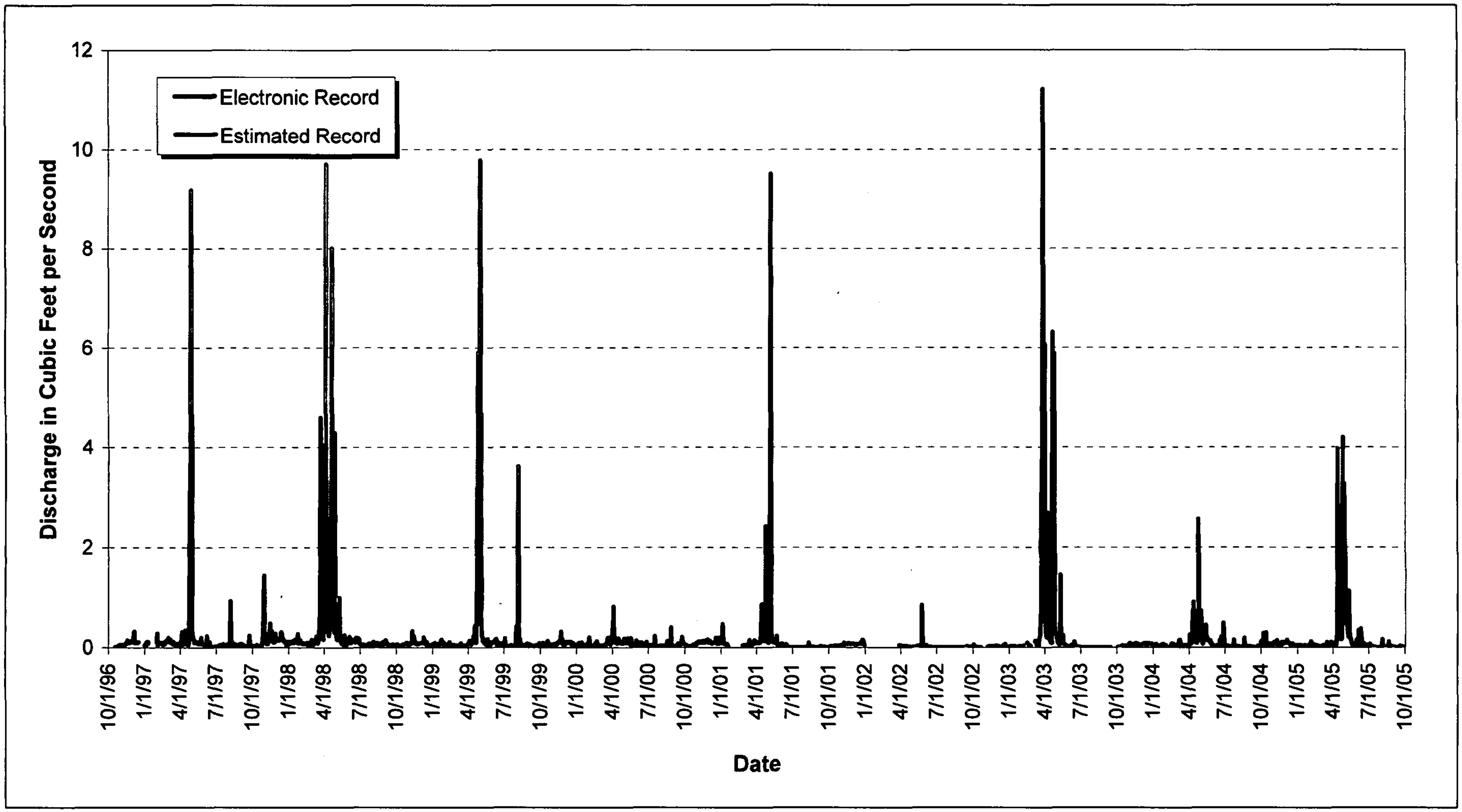


Figure 3-24. WY97-05 Mean Daily Hydrograph at GS05: North Woman Creek at West Fenceline.

3.2.8 GS06: Owl Branch at West Fenceline

Location

Owl Branch east of west Site boundary; State Plane: E2078449, N745968

Drainage Area

- The basin includes the Owl Branch of Woman Creek (total drainage acreage undetermined)
- IA Areas draining to GS06: none

Period of Record

9/23/91 to 6/7/05 (removed from service)

Gage

Water-stage recorder and 6" Parshall flume; weir insert installed 11/13/96

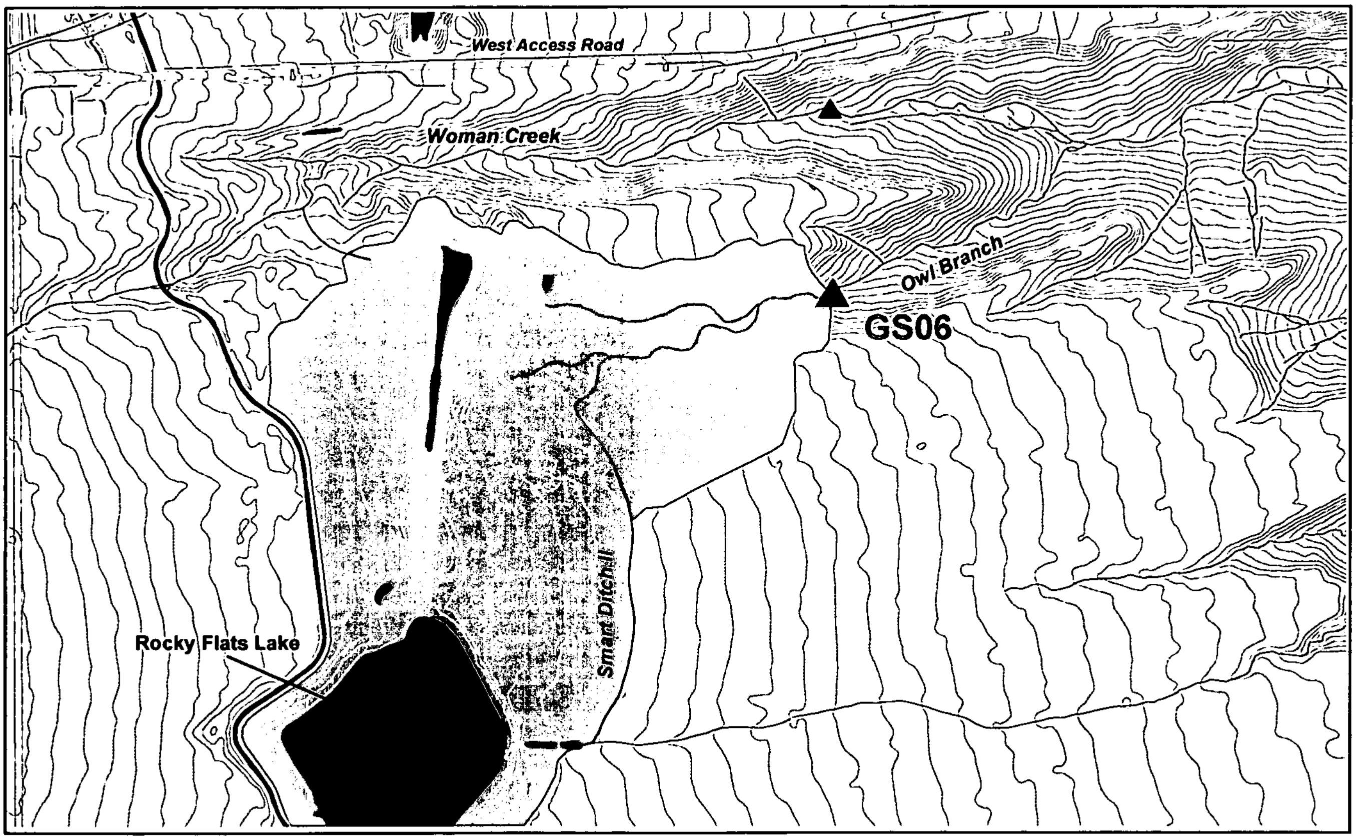


Figure 3-25. Map Showing GS06 Drainage Area.

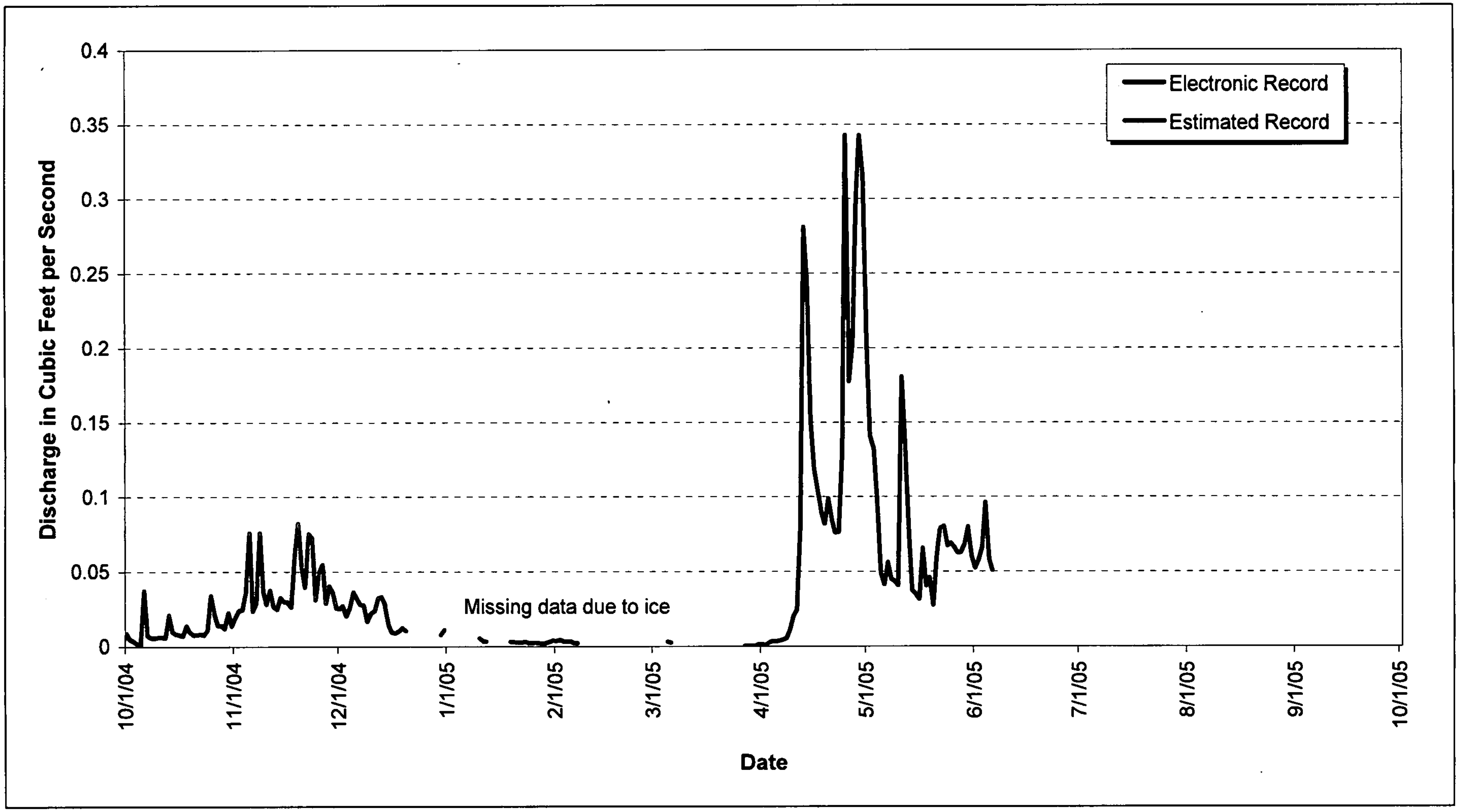


Figure 3-26. WY05 Mean Daily Hydrograph at GS06: South Woman Creek at West Fenceline.

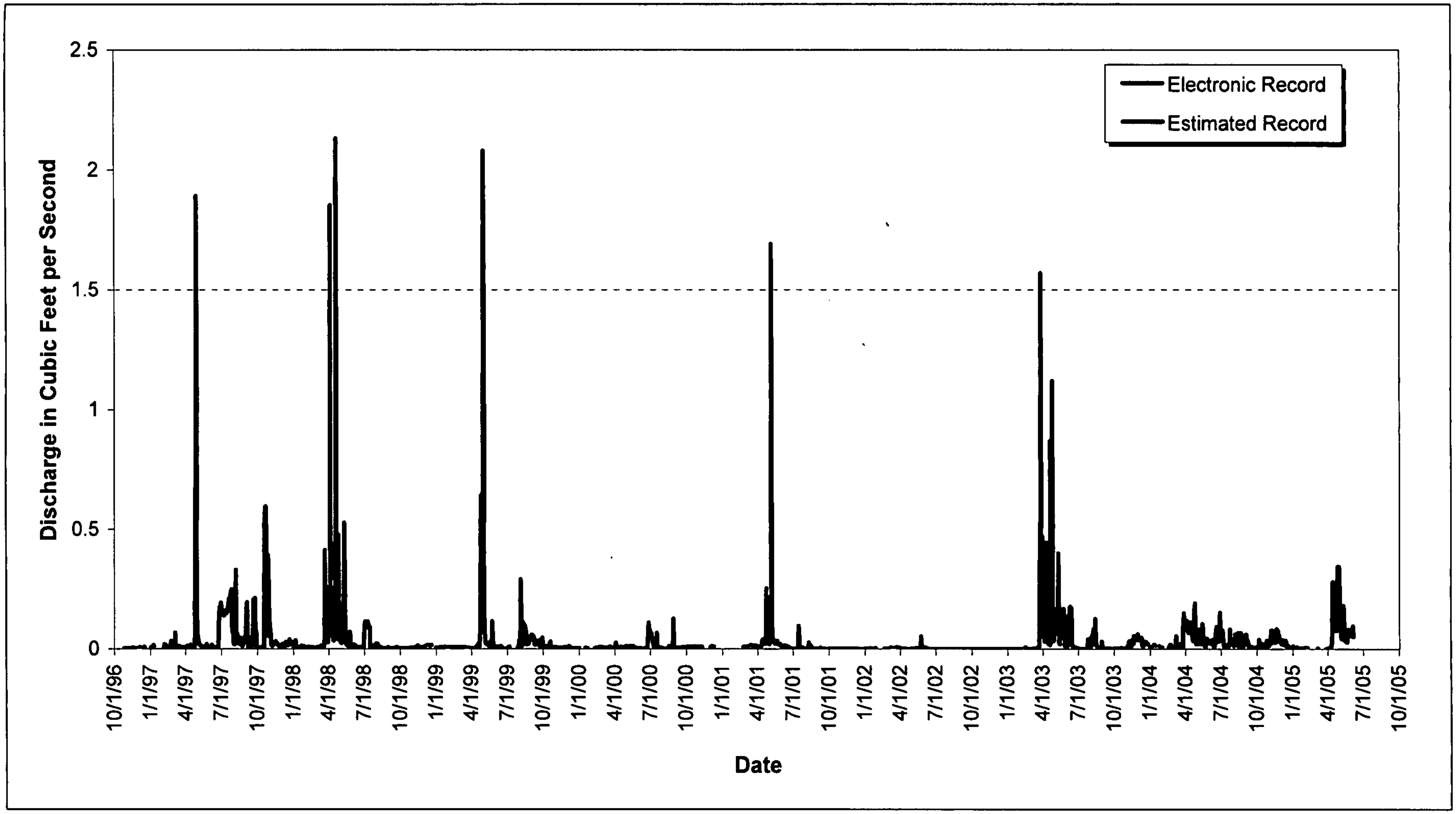


Figure 3-27. WY97-05 Mean Daily Hydrograph at GS06: South Woman Creek at West Fenceline.

3.2.9 GS08: South Walnut Creek at Pond B-5 Outlet

Location

South Walnut Creek at Pond B-5 outlet; State Plane: E2089779, N752234

Drainage Area

- The basin includes the South Walnut Creek drainage and southern portions of the IA (total of 262.7 acres); Pond B-1 and B-2 are normally pump transferred to the A-Series Ponds
- IA Areas draining to GS08: 900, 800, 700, 500, 600, 400, 300, and 100

Period of Record

3/23/94 to current year

Gage

Water-stage recorder and 24" Parshall flume

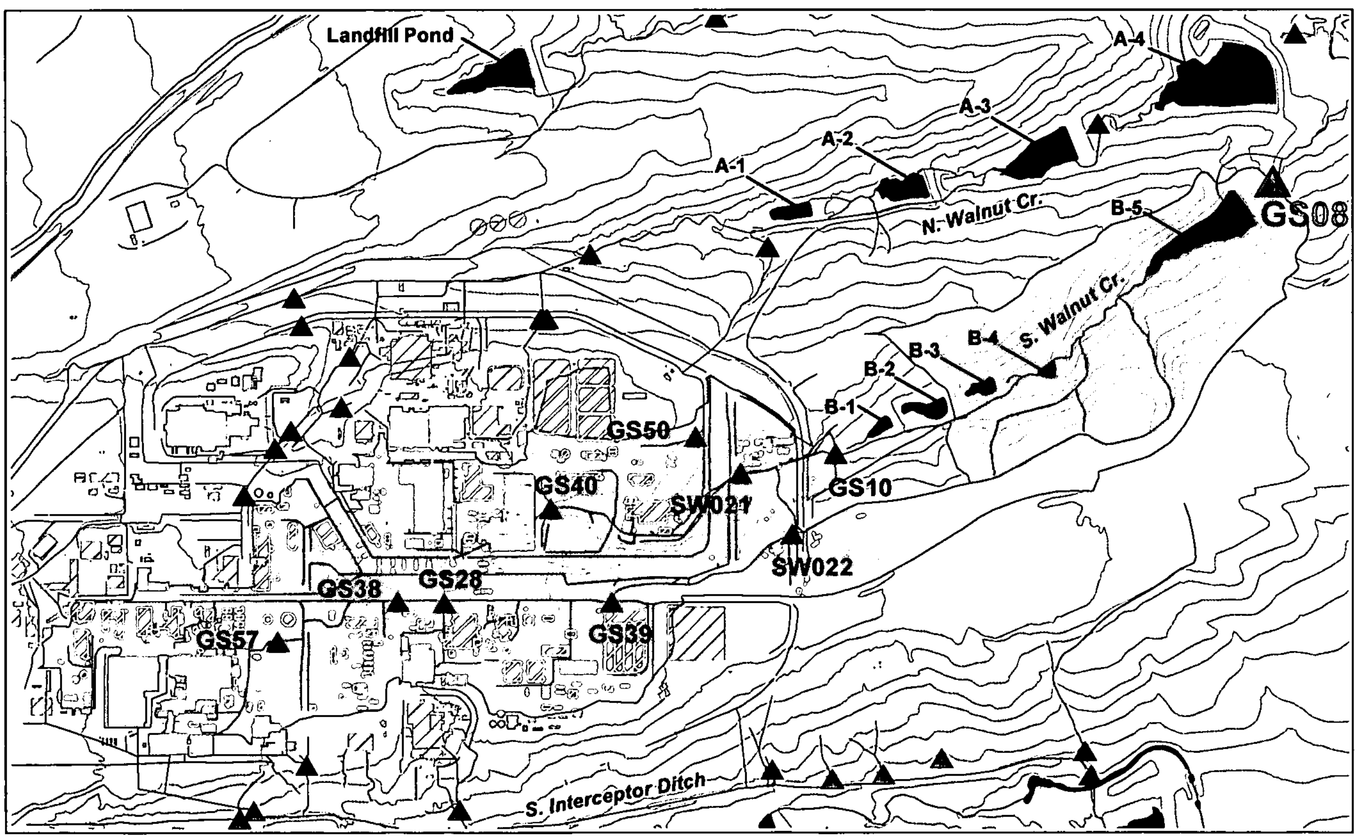


Figure 3-28. Map Showing GS08 Drainage Area.

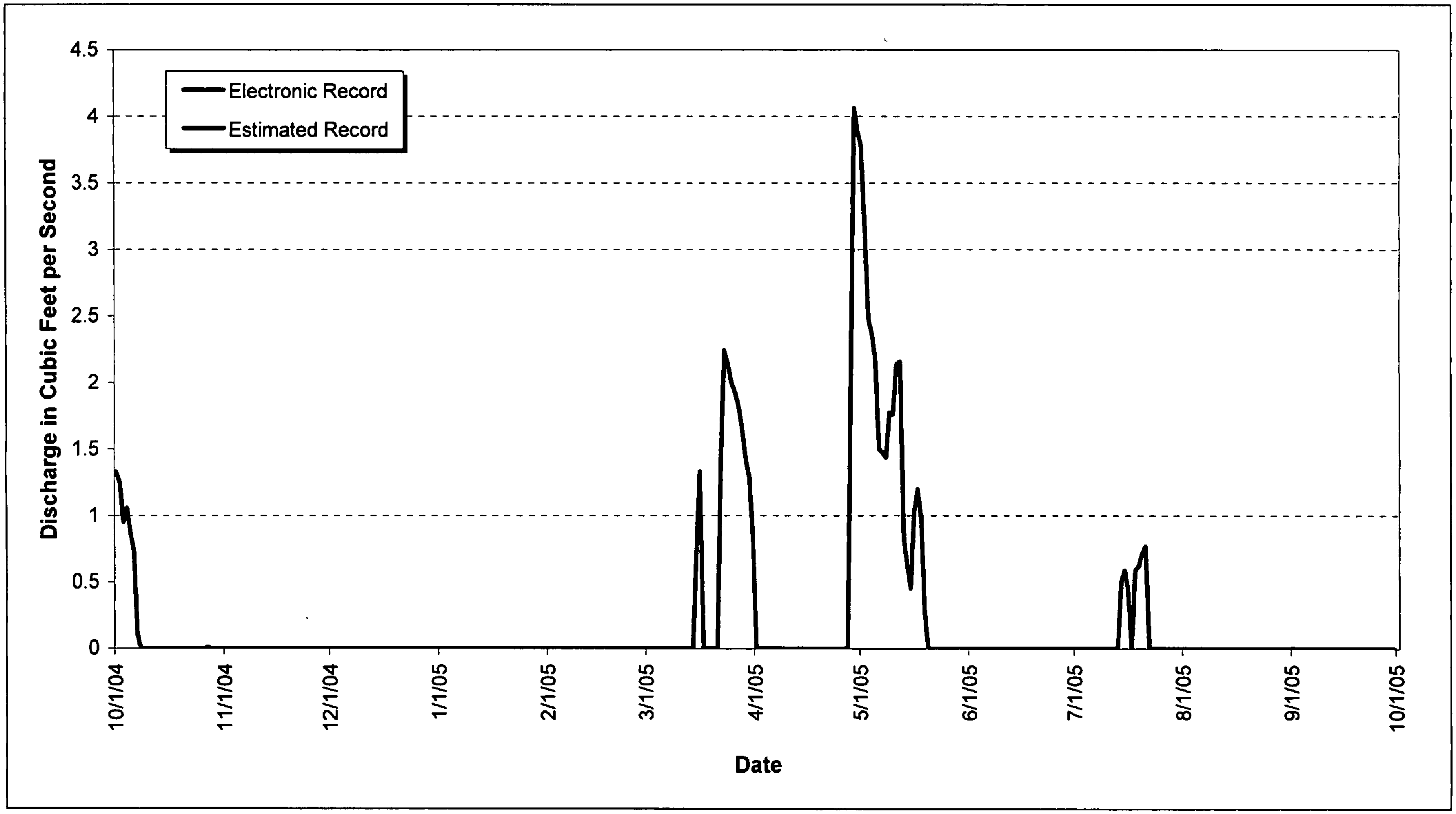


Figure 3-29. WY05 Mean Daily Hydrograph at GS08: South Walnut Creek at Pond B-5 Outlet.

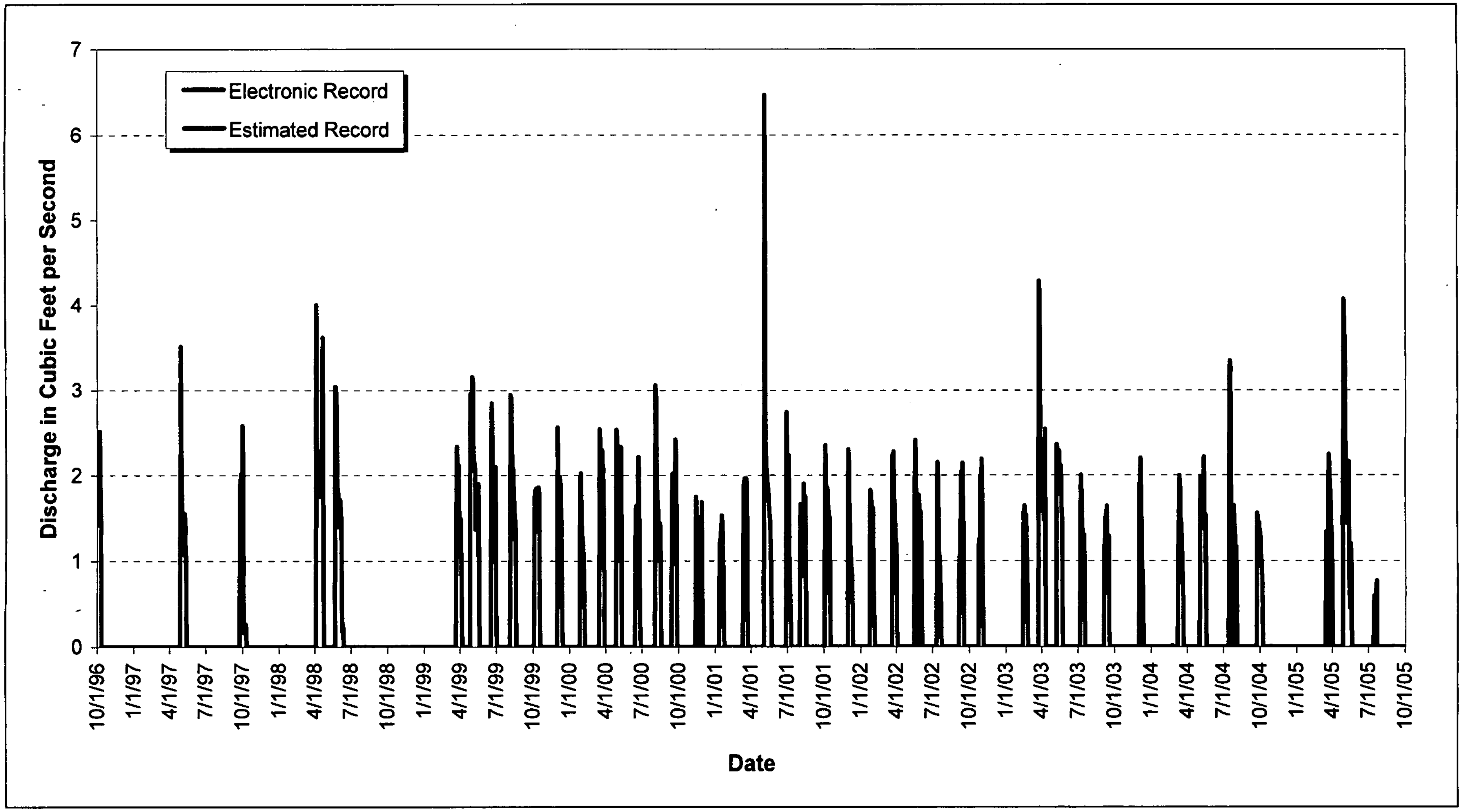


Figure 3-30. WY97-05 Mean Daily Hydrograph at GS08: South Walnut Creek at Pond B-5 Outlet.

3.2.10 GS10: South Walnut Creek at B-1 Bypass

Location

South Walnut Creek above B-1 Bypass; State Plane: E2086741, N750326

Drainage Area

- The basin includes the central and southern portions of the IA (total of 173.1 acres)
- IA Areas draining to GS10: 900, 800, 700, 600, 500, 400, 300, and 100

Period of Record

4/1/93 to current year

Gage

Water-stage recorder and 9” Parshall flume

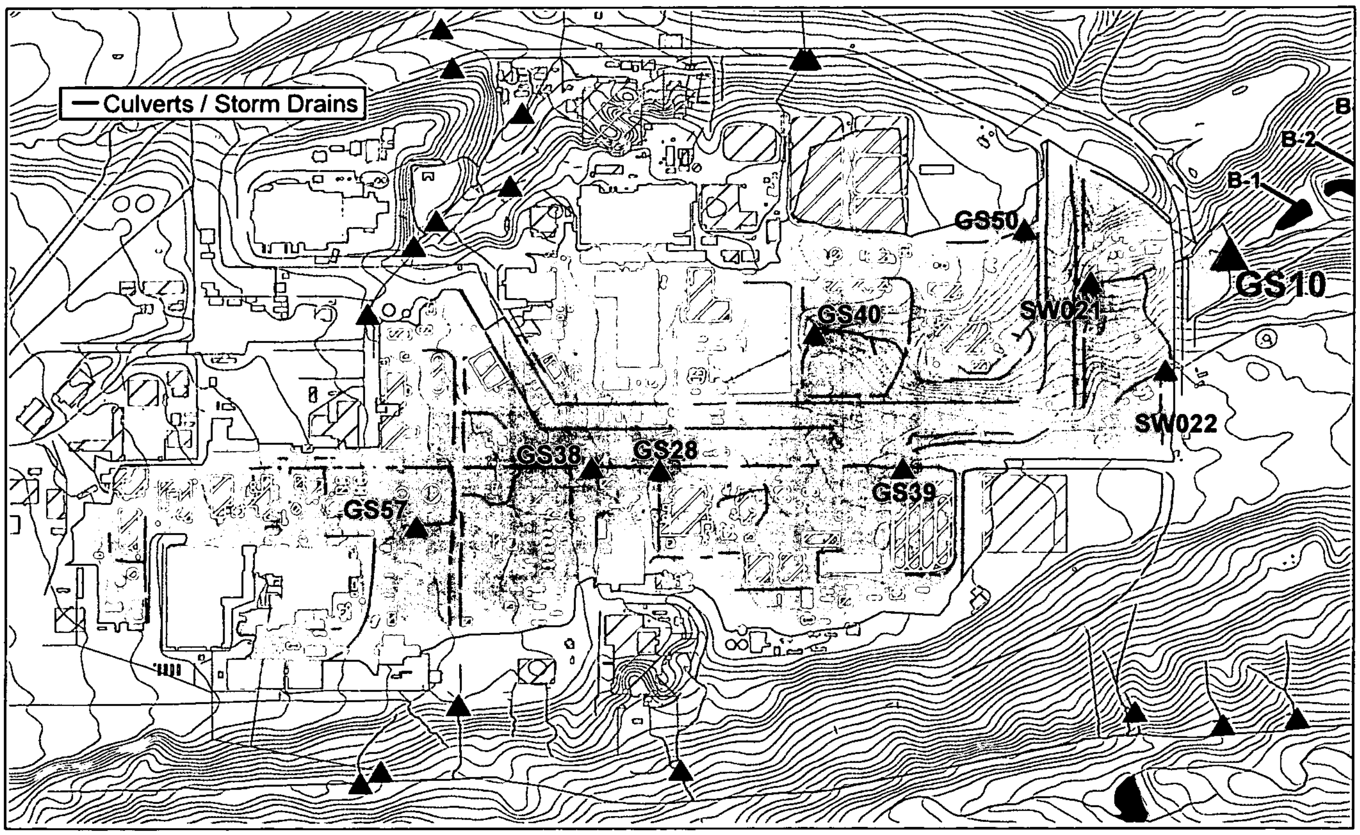


Figure 3-31. Map Showing GS10 Drainage Area.

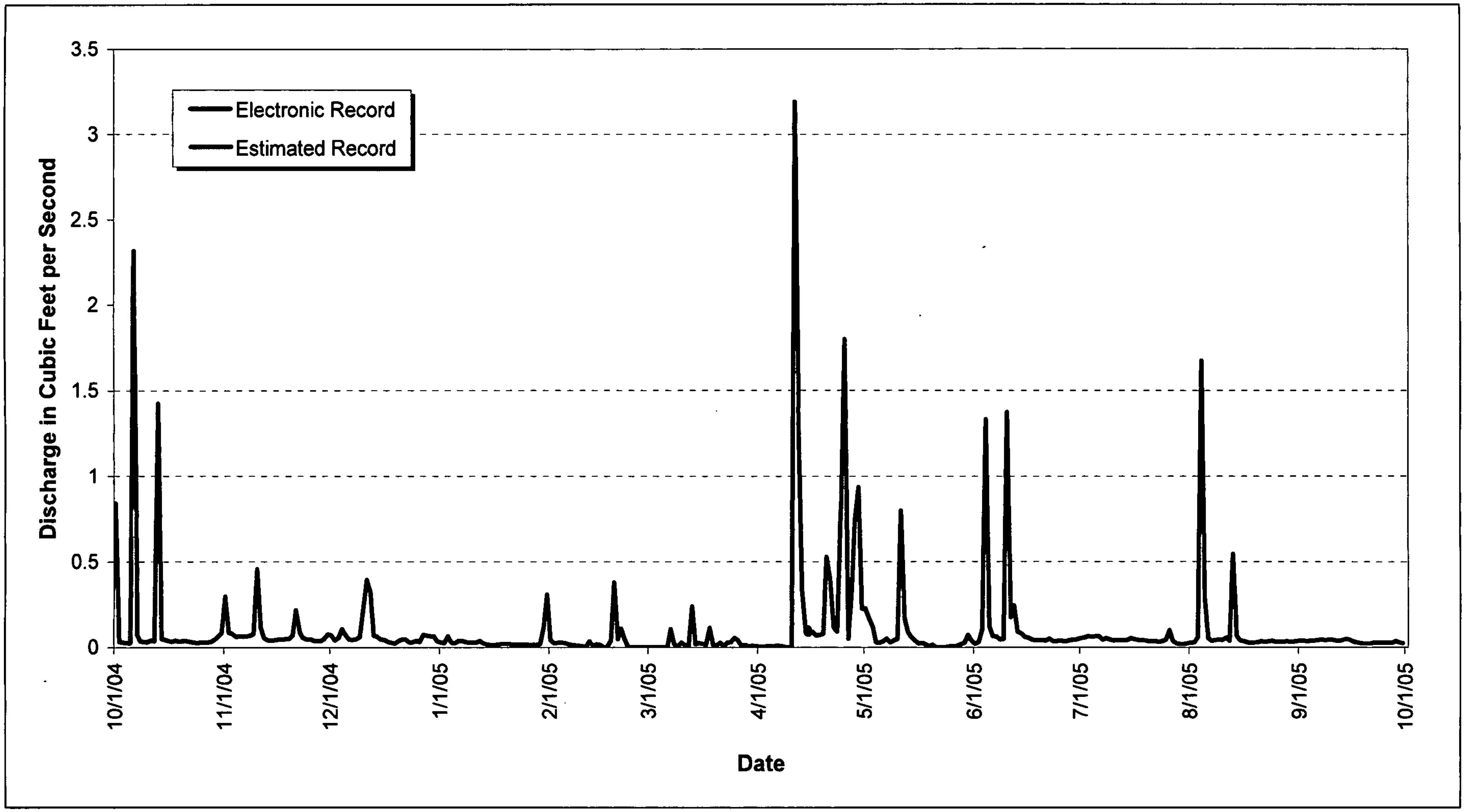


Figure 3-32. WY05 Mean Daily Hydrograph at GS10: South Walnut Creek at B-1 Bypass.

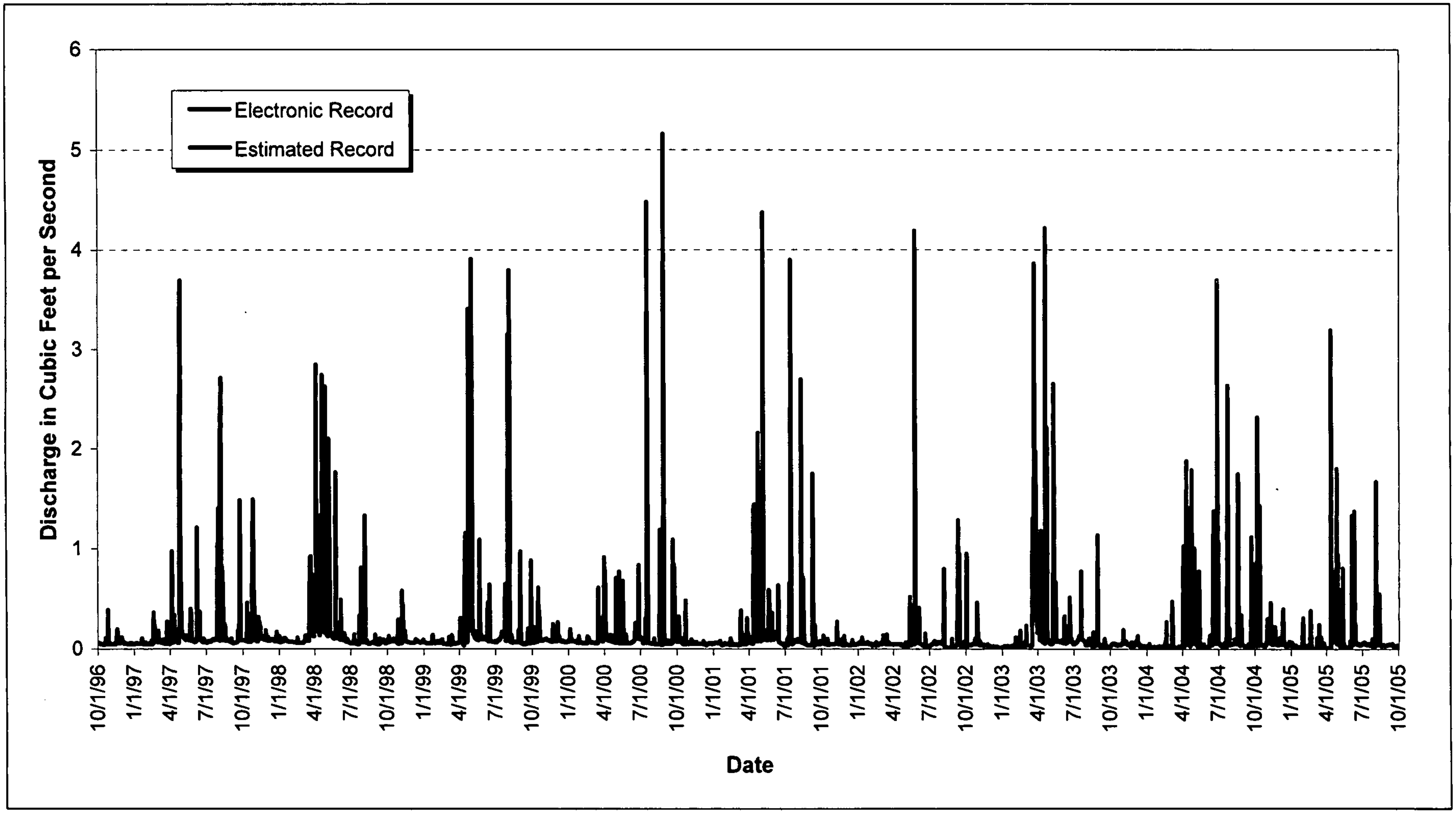


Figure 3-33. WY97-05 Mean Daily Hydrograph at GS10: South Walnut Creek at B-1 Bypass.

3.2.11 GS11: North Walnut Creek at Pond A-4 Outlet

Location

North Walnut Creek at Pond A-4 outlet; State Plane: E2089934, N753267

Drainage Area

- The basin includes the North Walnut Creek drainage, the Landfill Pond (pump transferred to A-Series Ponds), Ponds B-1 and B-2 (normally pump transferred to the A-Series Ponds), and northern portions of the IA (total of 449.8 acres)
- IA Areas draining to GS11: 900, 700, 300, and 100

Period of Record

5/12/92 to current year

Gage

Water-stage recorder and 24" Parshall flume

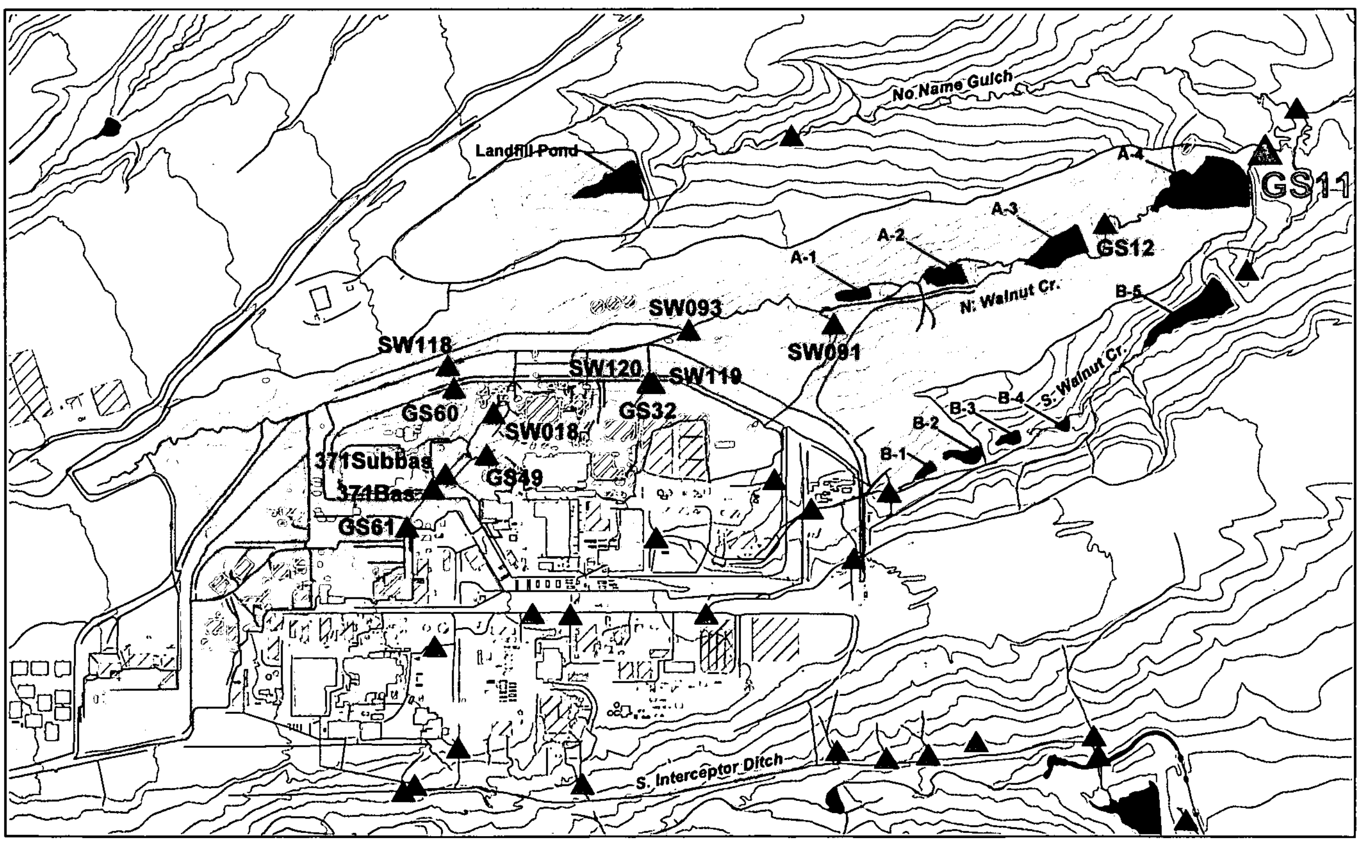


Figure 3-34. Map Showing GS11 Drainage Area.

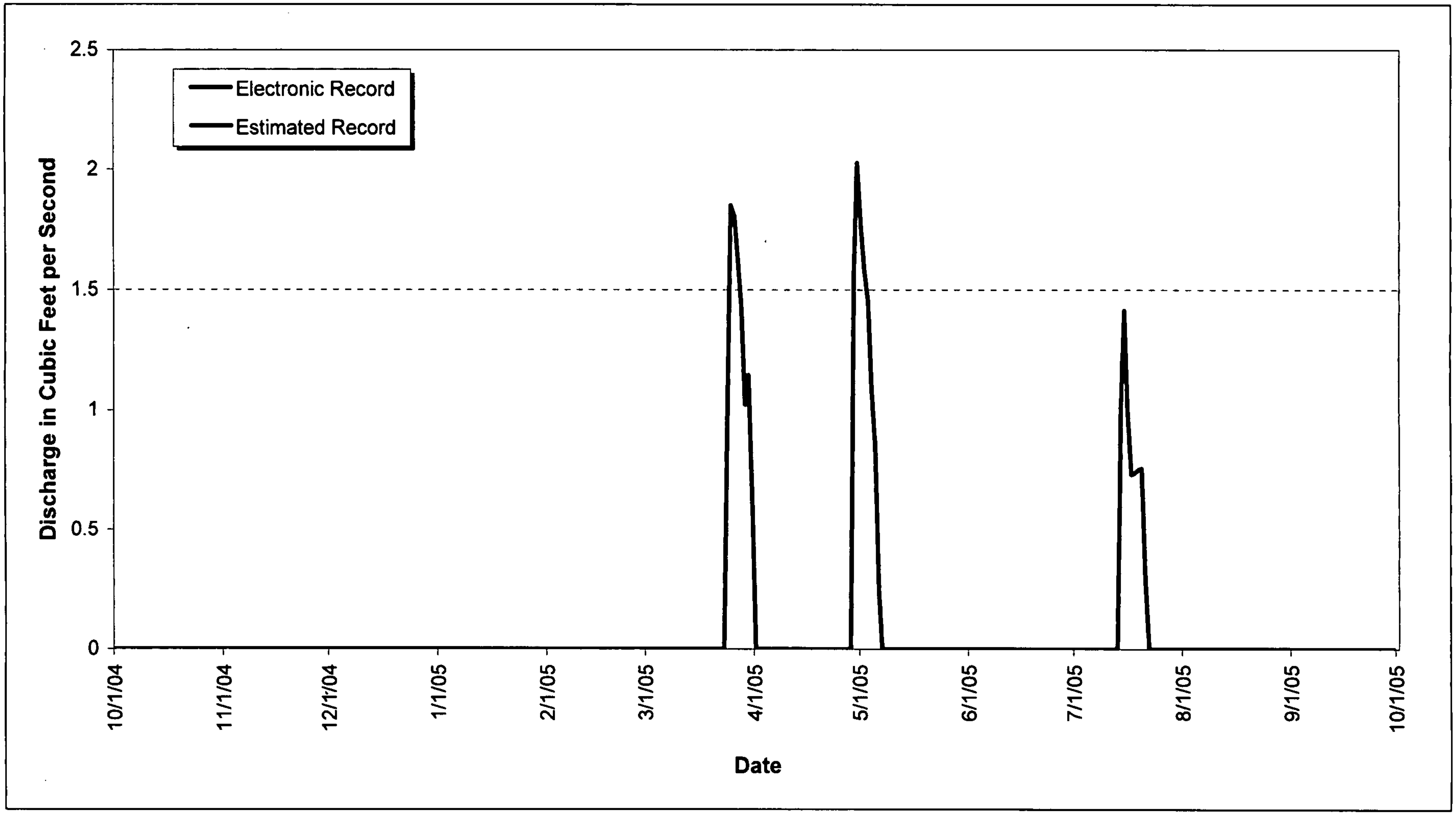


Figure 3-35. WY05 Mean Daily Hydrograph at GS11: North Walnut Creek at Pond A-4 Outlet.

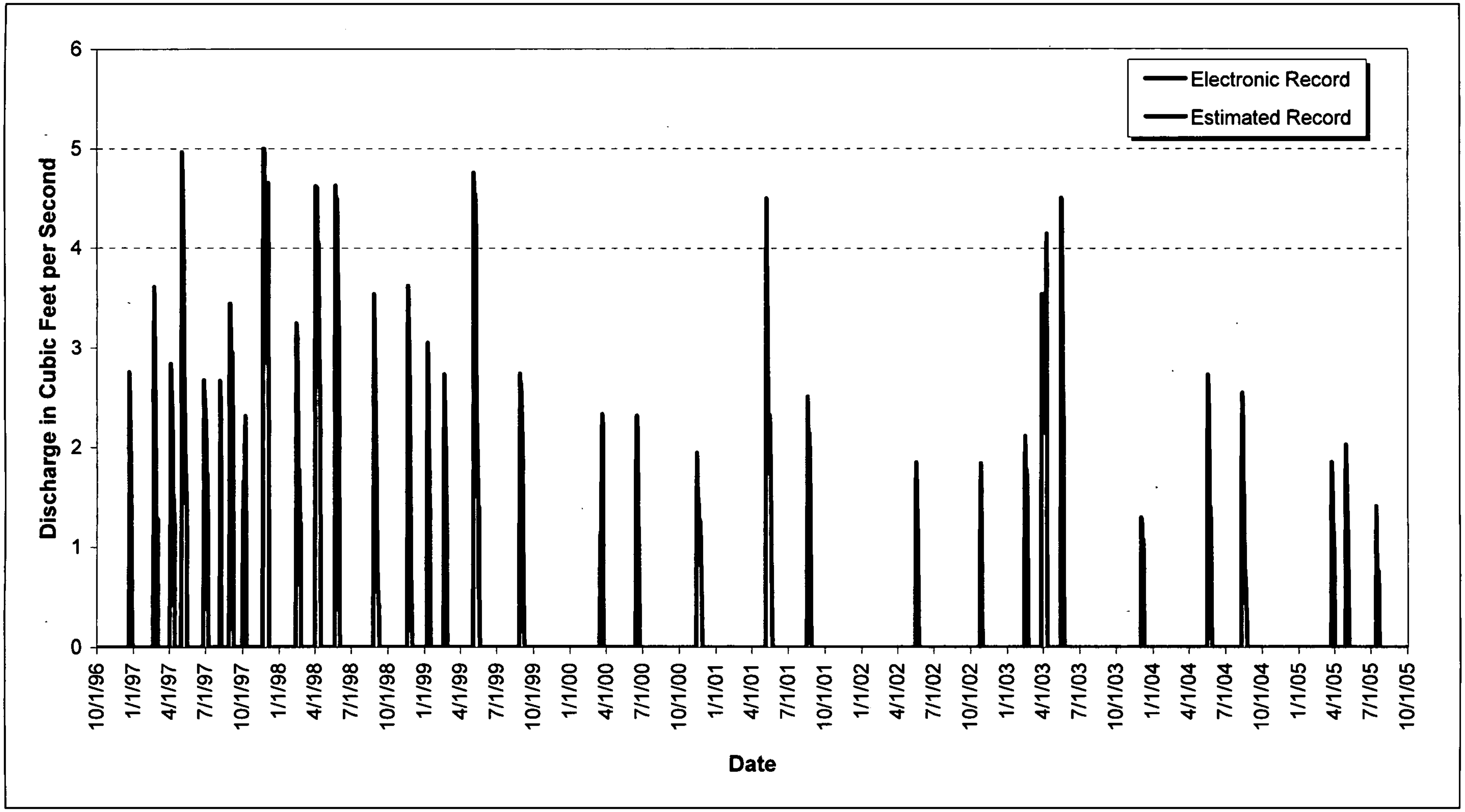


Figure 3-36. WY97-05 Mean Daily Hydrograph at GS11: North Walnut Creek at Pond A-4 Outlet.

3.2.12 GS12: North Walnut Creek at Pond A-3 Outlet

Location

North Walnut Creek at Pond A-3 outlet; State Plane: E2088569, N752633

Drainage Area

- The basin includes the North Walnut Creek drainage, the Landfill Pond (pump transferred to A-Series Ponds), Ponds B-1 and B-2 (normally pump transferred to the A-Series Ponds), and northern portions of the IA (total of 415.4 acres)
- IA Areas draining to GS12: 900, 700, 300, and 100

Period of Record

5/13/92 to current year

Gage

Water-stage recorder and 30" Parshall flume

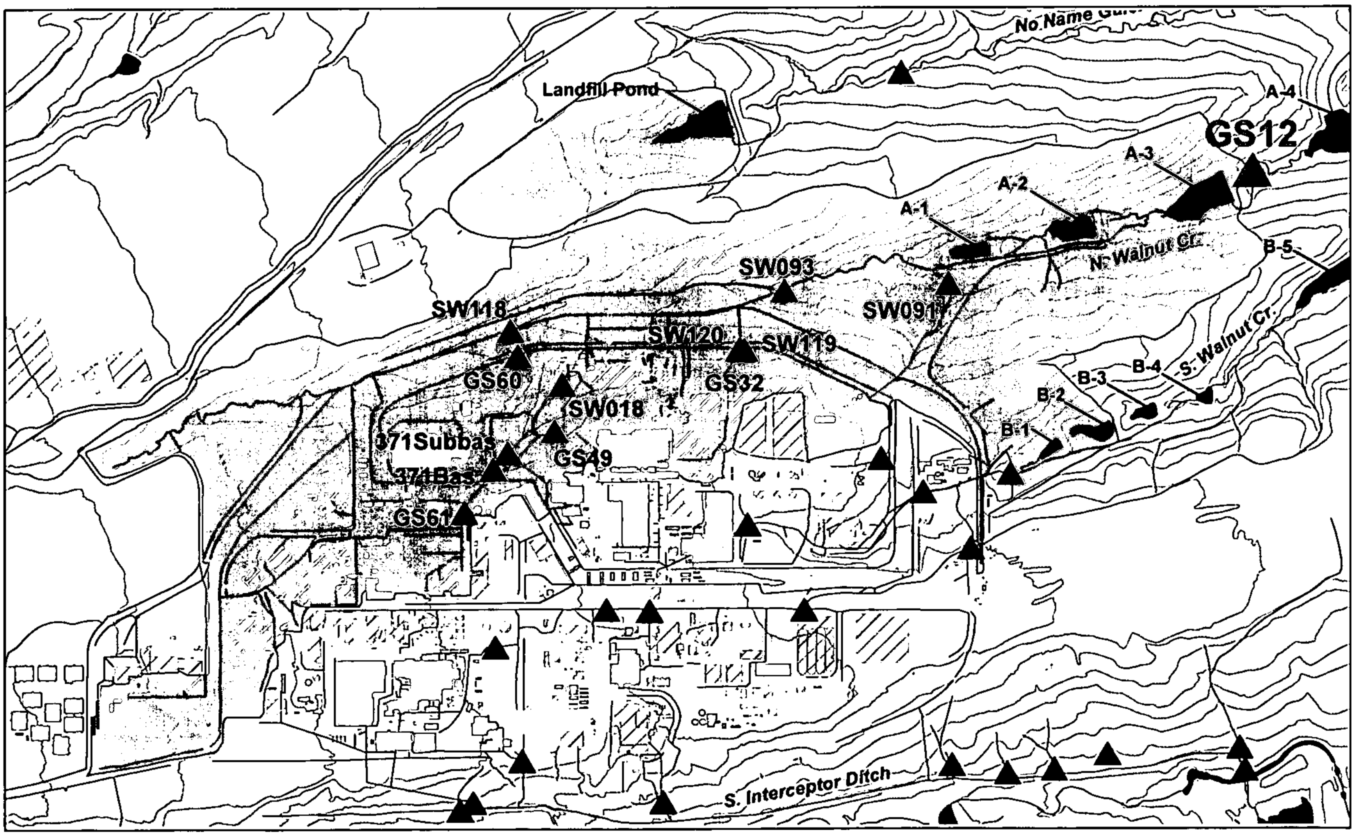


Figure 3-37. Map Showing GS12 Drainage Area.

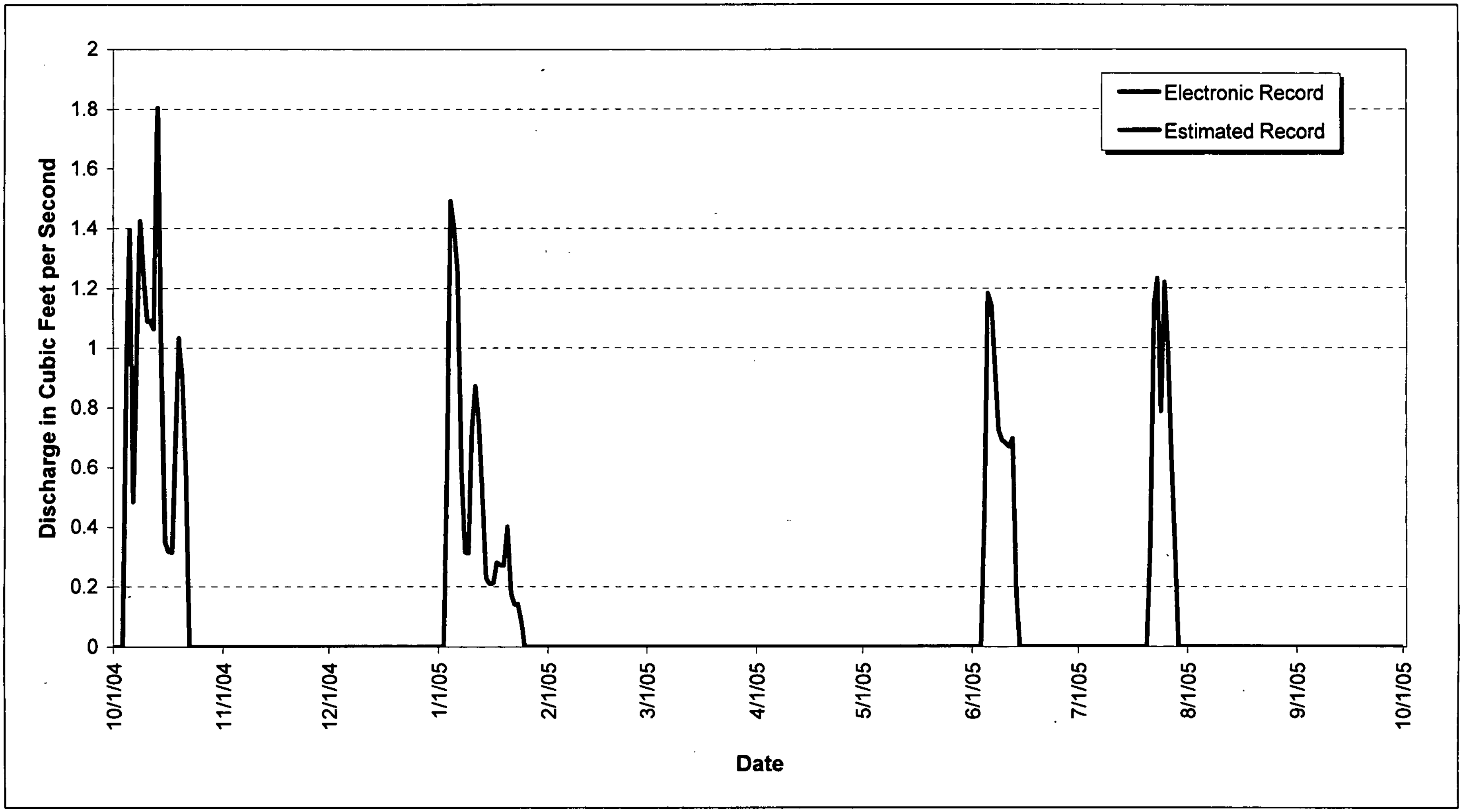


Figure 3-38. WY05 Mean Daily Hydrograph at GS12: North Walnut Creek at Pond A-3 Outlet.

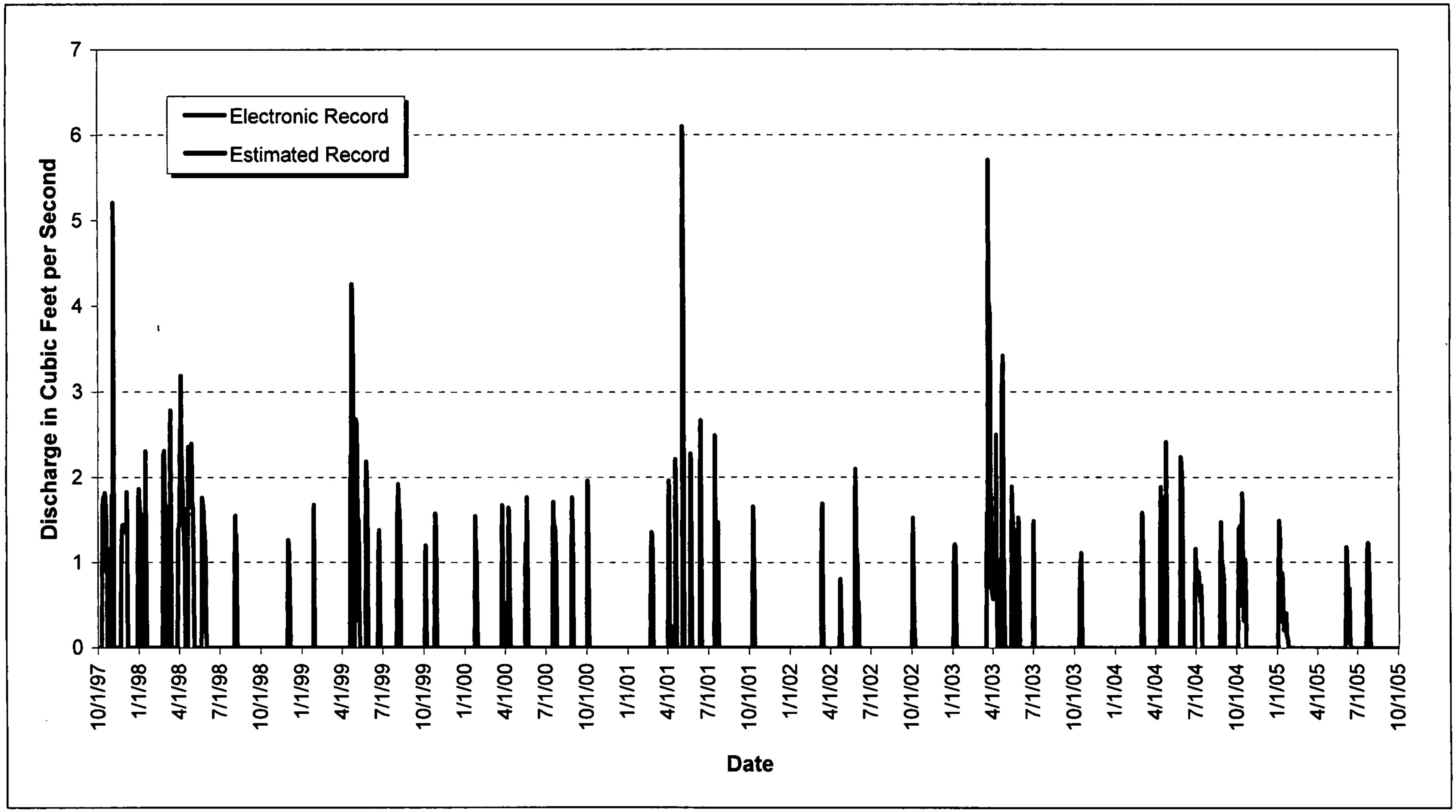


Figure 3-39. WY97-05 Mean Daily Hydrograph at GS12: North Walnut Creek at Pond A-3 Outlet.

3.2.13 GS16: Antelope Springs

Location

Antelope Springs Creek in southern BZ; State Plane: E2083406, N746659

Drainage Area

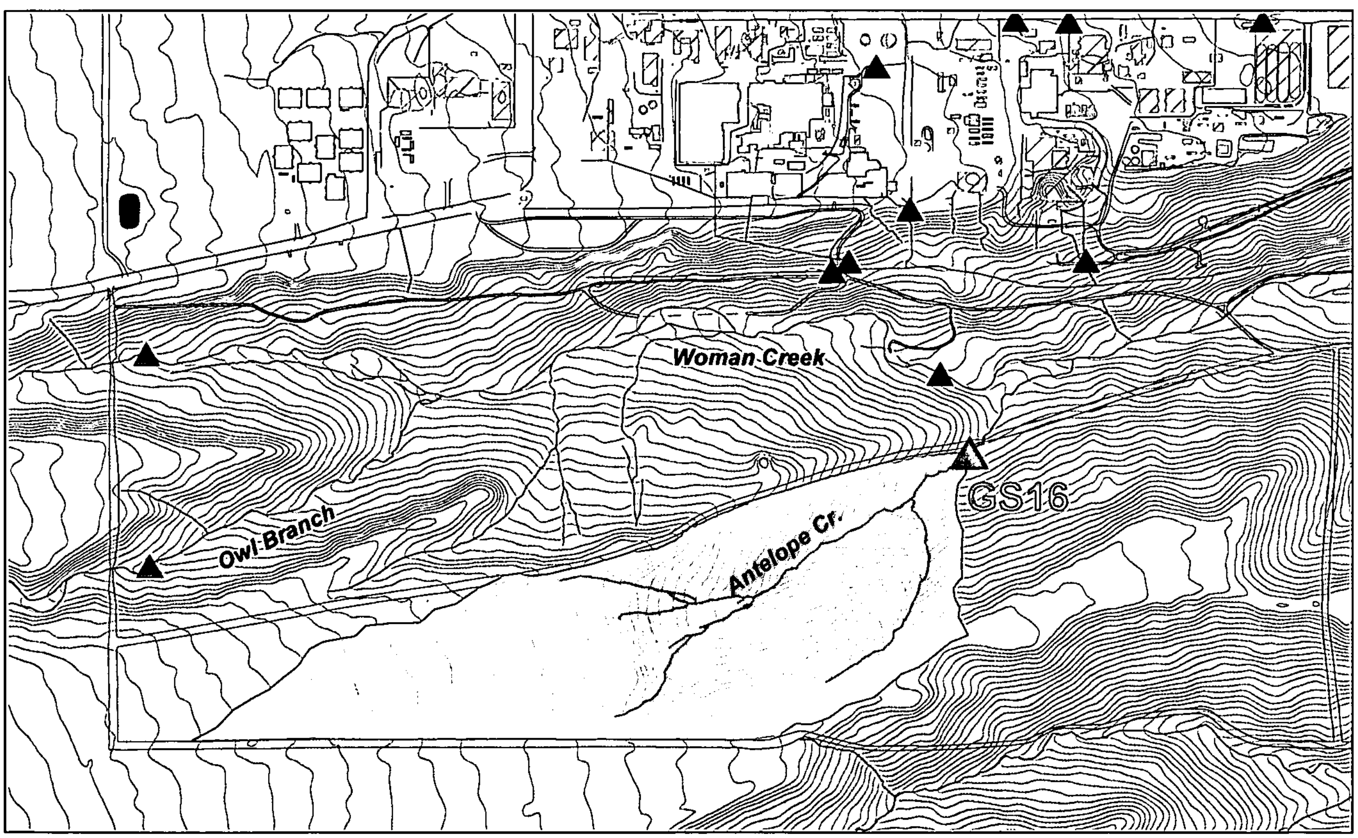
- The basin includes the Antelope Springs Creek drainage (total of 104.7 acres)
- IA Areas draining to GS16: none

Period of Record

4/8/93 to 9/30/05 (removed from service)

Gage

Water-stage recorder and 6" Parshall flume; 6" Parshall flume 150' downstream prior to 11/30/98



Note: Southern edge of GS16 drainage formed by BZ dirt road.

Figure 3-40. Map Showing GS16 Drainage Area.

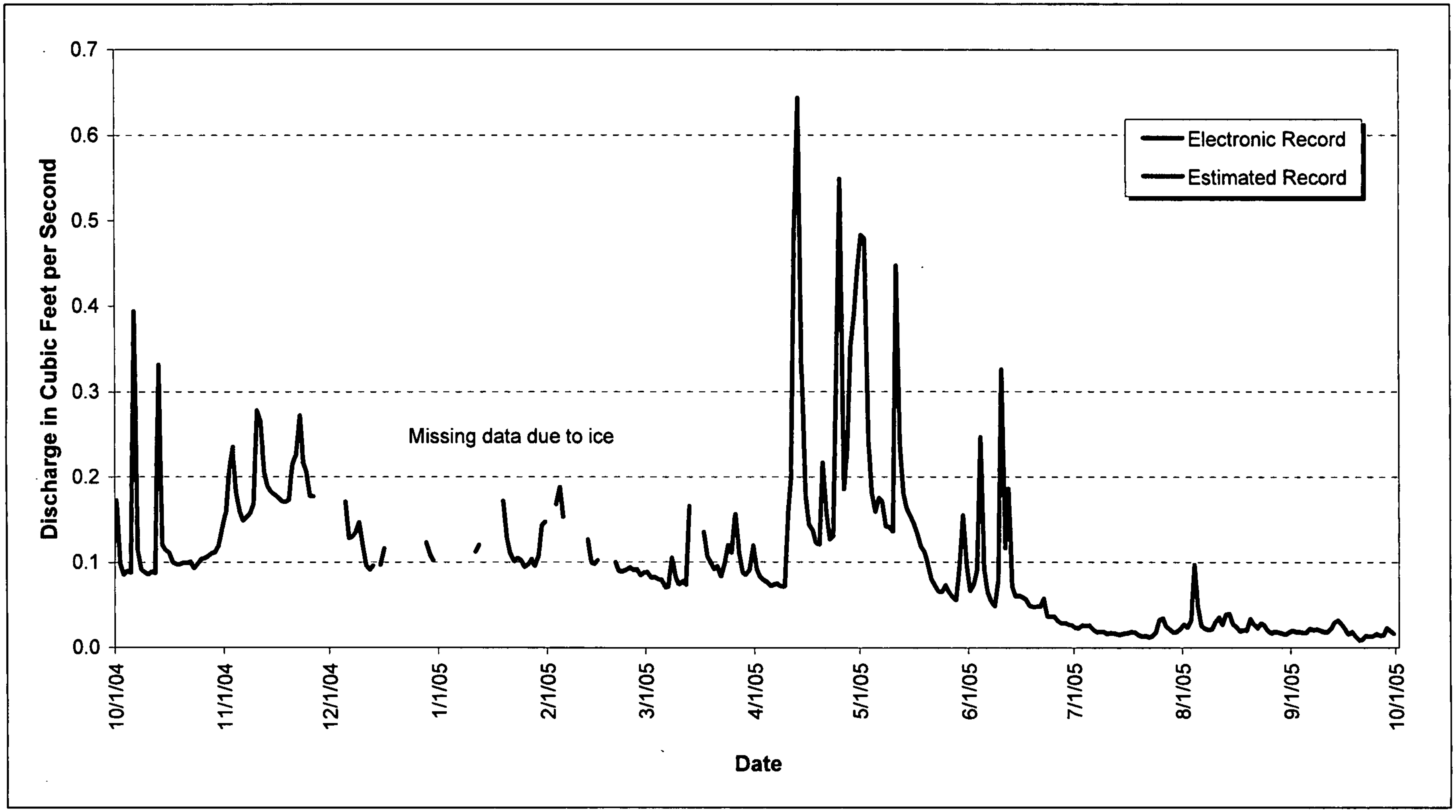


Figure 3-41. WY05 Mean Daily Hydrograph at GS16: Antelope Springs.

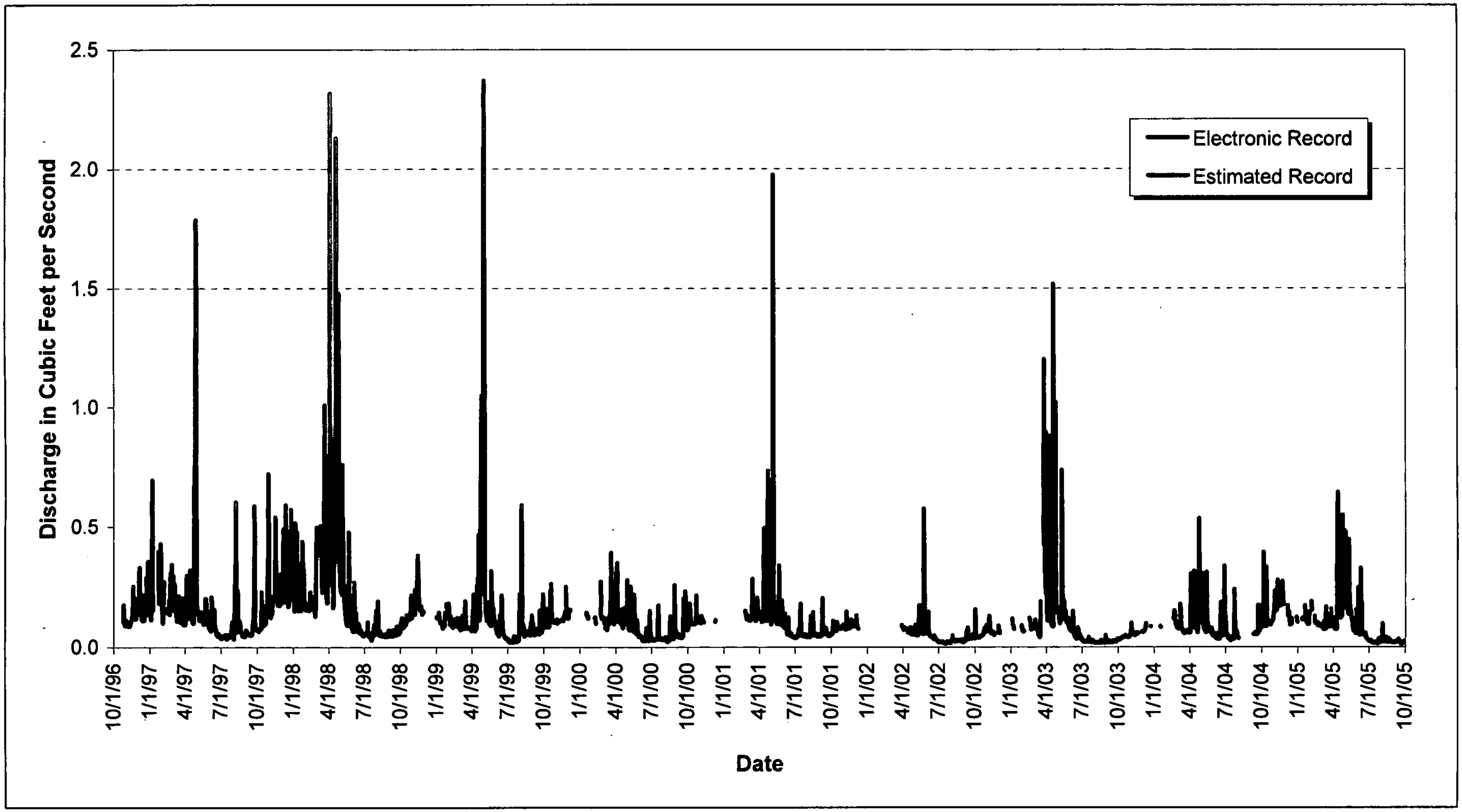


Figure 3-42. WY97-05 Mean Daily Hydrograph at GS16: Antelope Springs.

3.2.14 GS21: B664 Area Outfall to SID

Location

Culvert southeast of B664; State Plane: E2082678, N747820

Drainage Area

- The basin includes the area SE of B664 (total of 2.4 acres)
- IA Areas draining to GS21: 600

Period of Record

4/13/95 – 9/1/96; 12/11/02 to 6/30/05 (removed from service)

Gage

Water-stage recorder and 4" cutthroat flume to 9/1/96; 1' H-flume starting 12/10/02

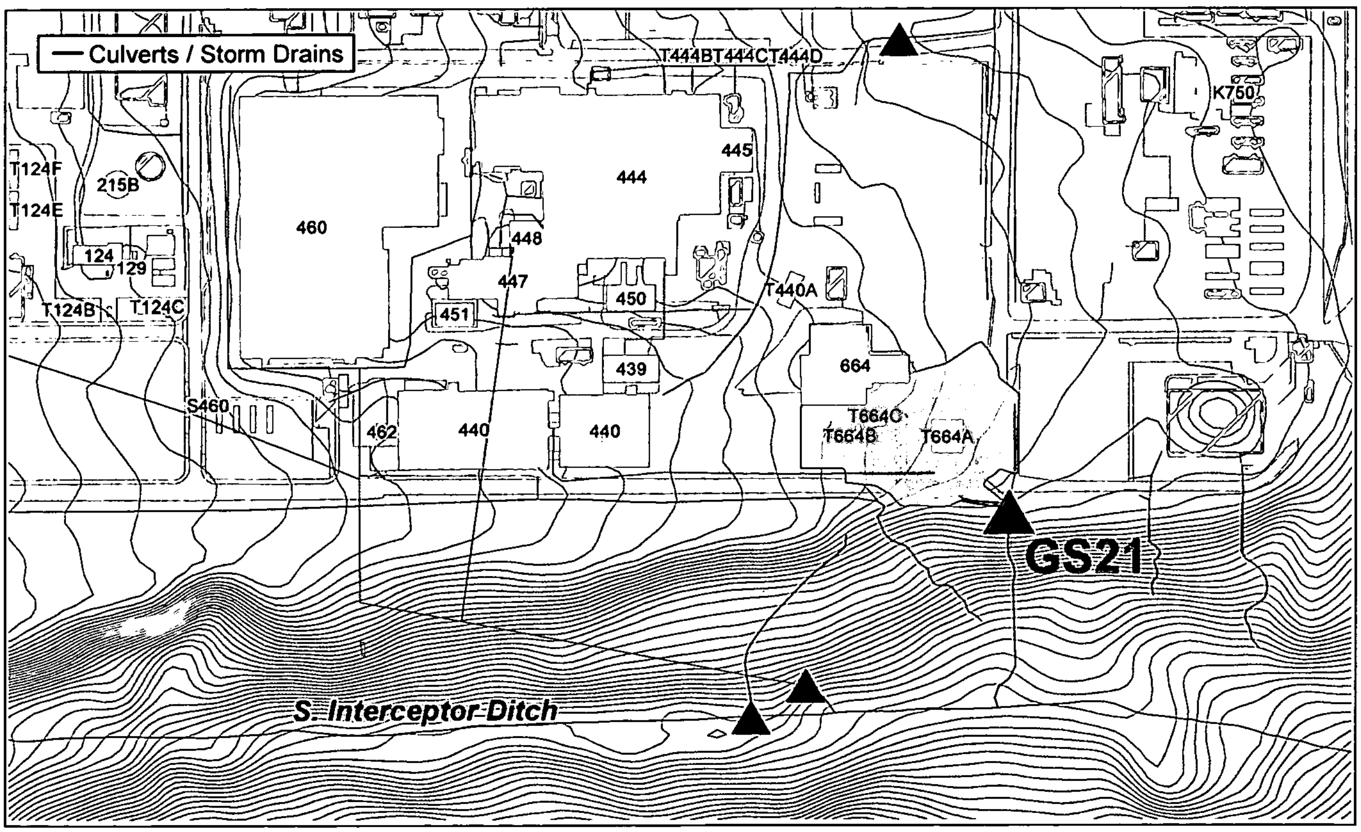


Figure 3-43. Map Showing GS21 Drainage Area.

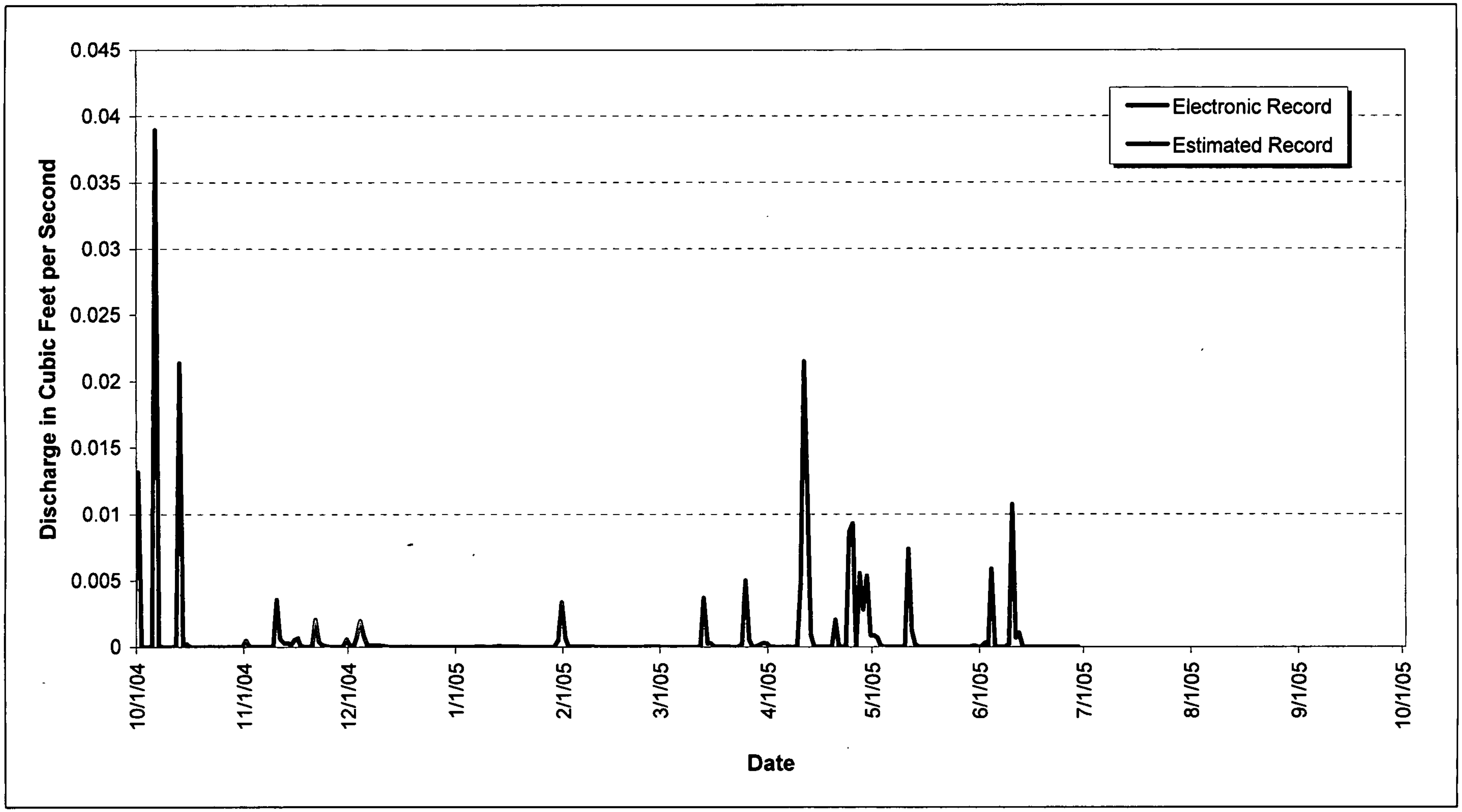


Figure 3-44. WY05 Mean Daily Hydrograph at GS21: B664 Area Outfall to SID.

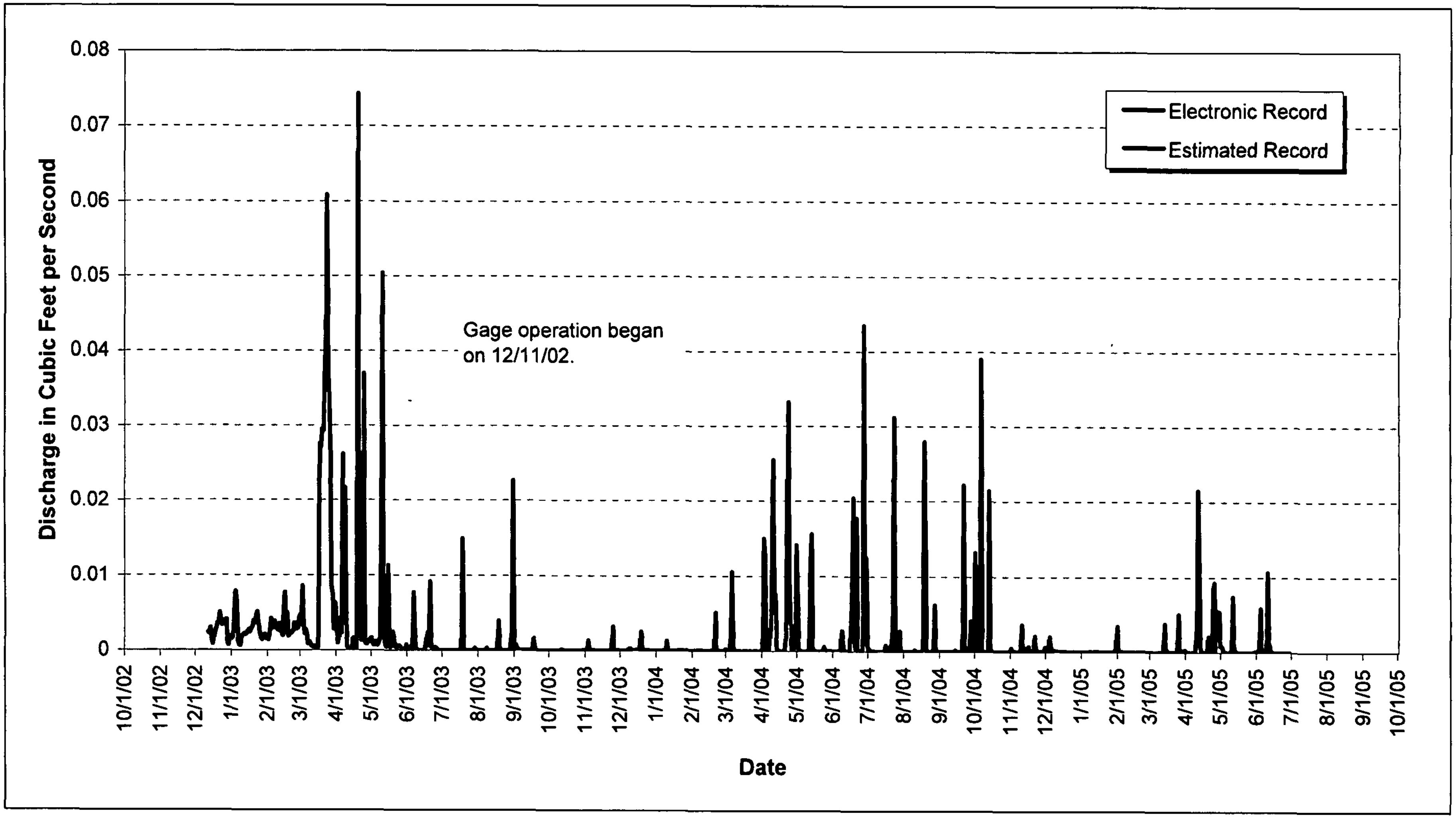


Figure 3-45. WY03-05 Mean Daily Hydrograph at GS21: B664 Area Outfall to SID.

3.2.15 GS22: 400 Area Outfall to SID

Location

400 Area outfall to SID (flow is routed to GS22 via underground storm drain); State Plane: E2082678, N747820

Drainage Area

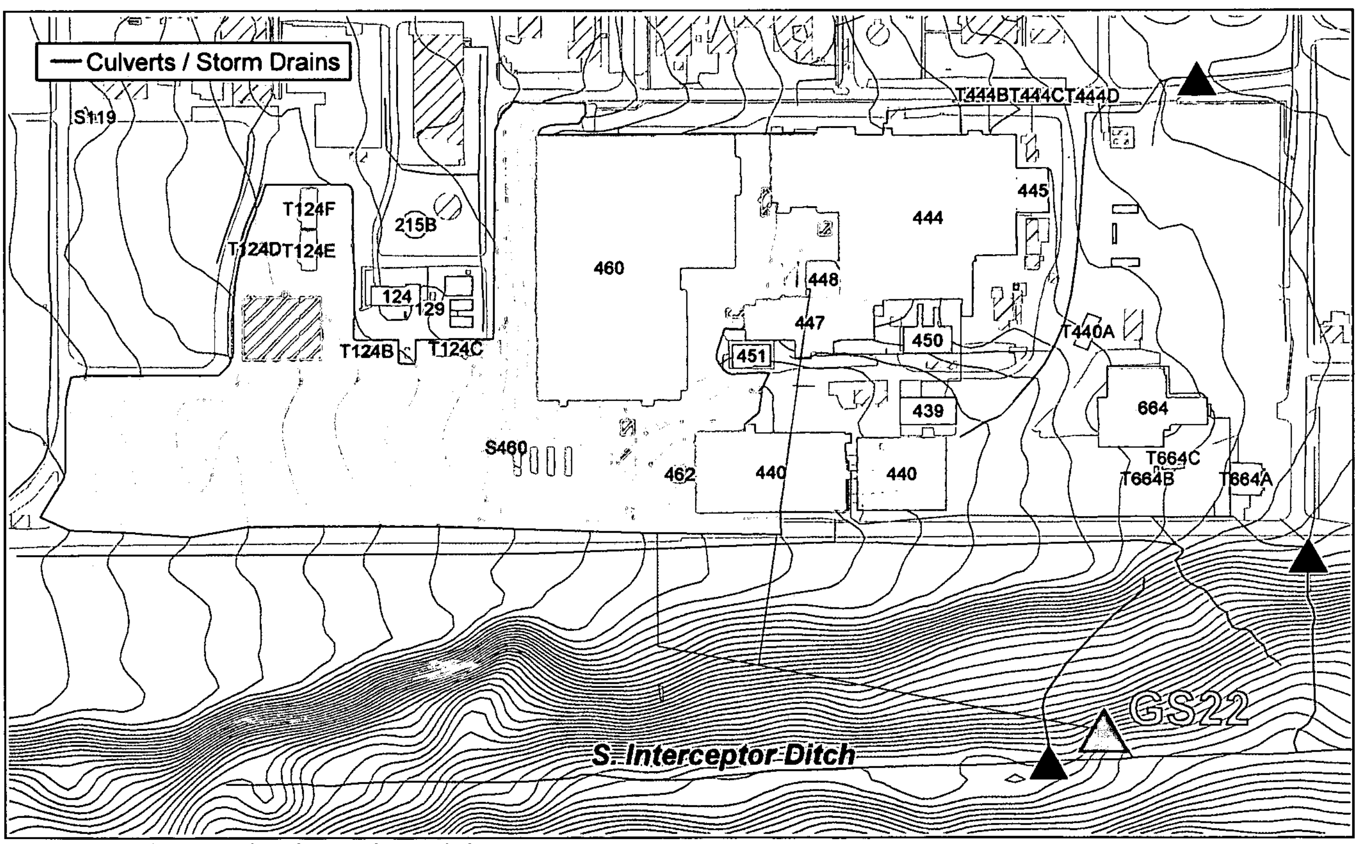
- The basin includes a portion of the southern IA (total of 17.2 acres)
- IA Areas draining to GS22: 400 and 100

Period of Record

4/18/95 – 10/1/96; 1/7/00 to 3/24/05 (removed from service)

Gage

Water-stage recorder and 1.5' H-flume



Note: Water reaches GS22 via underground storm drains.

Figure 3-46. Map Showing GS22 Drainage Area.

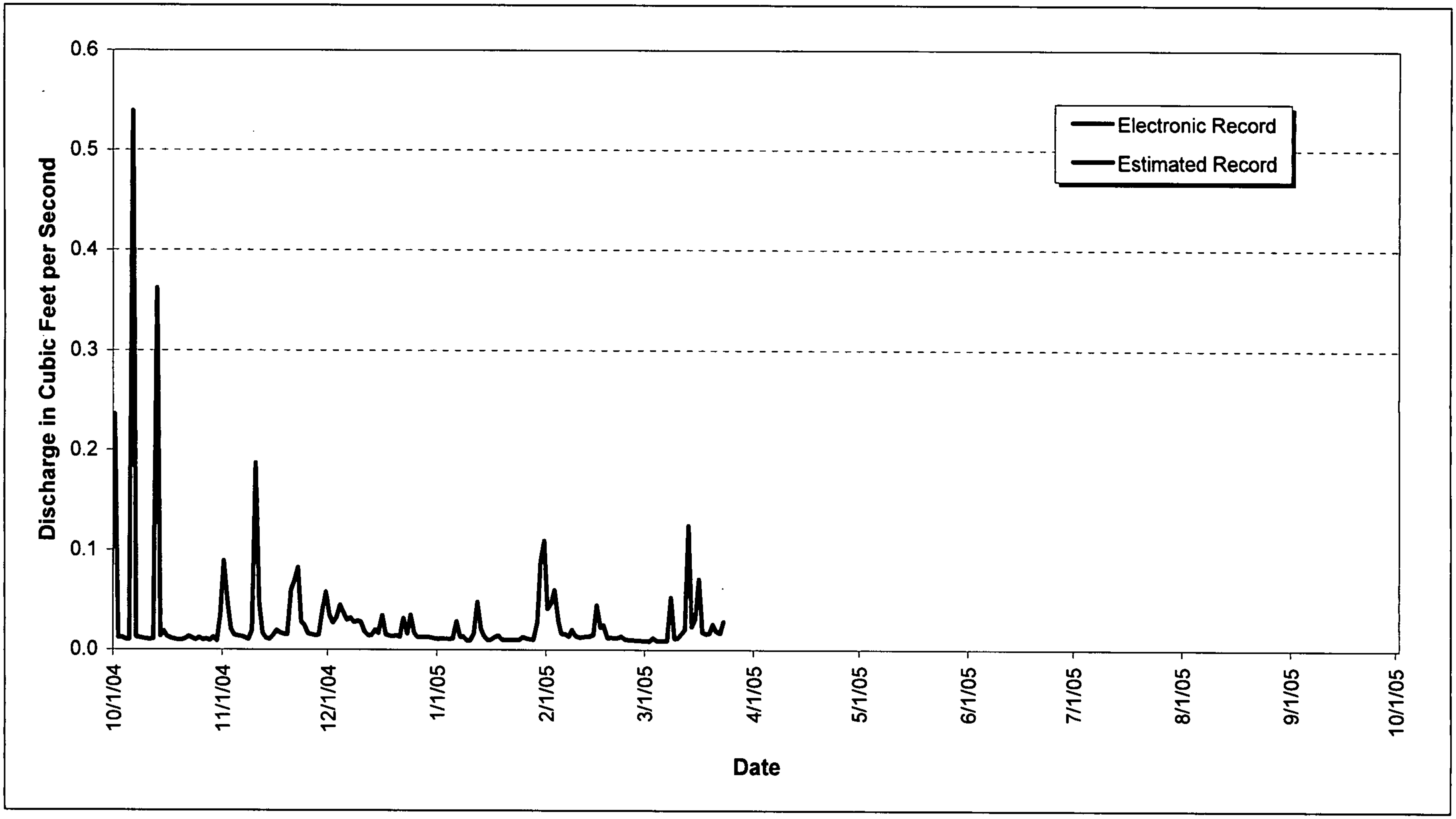


Figure 3-47. WY05 Mean Daily Hydrograph at GS22: 400 Area Outfall to SID.

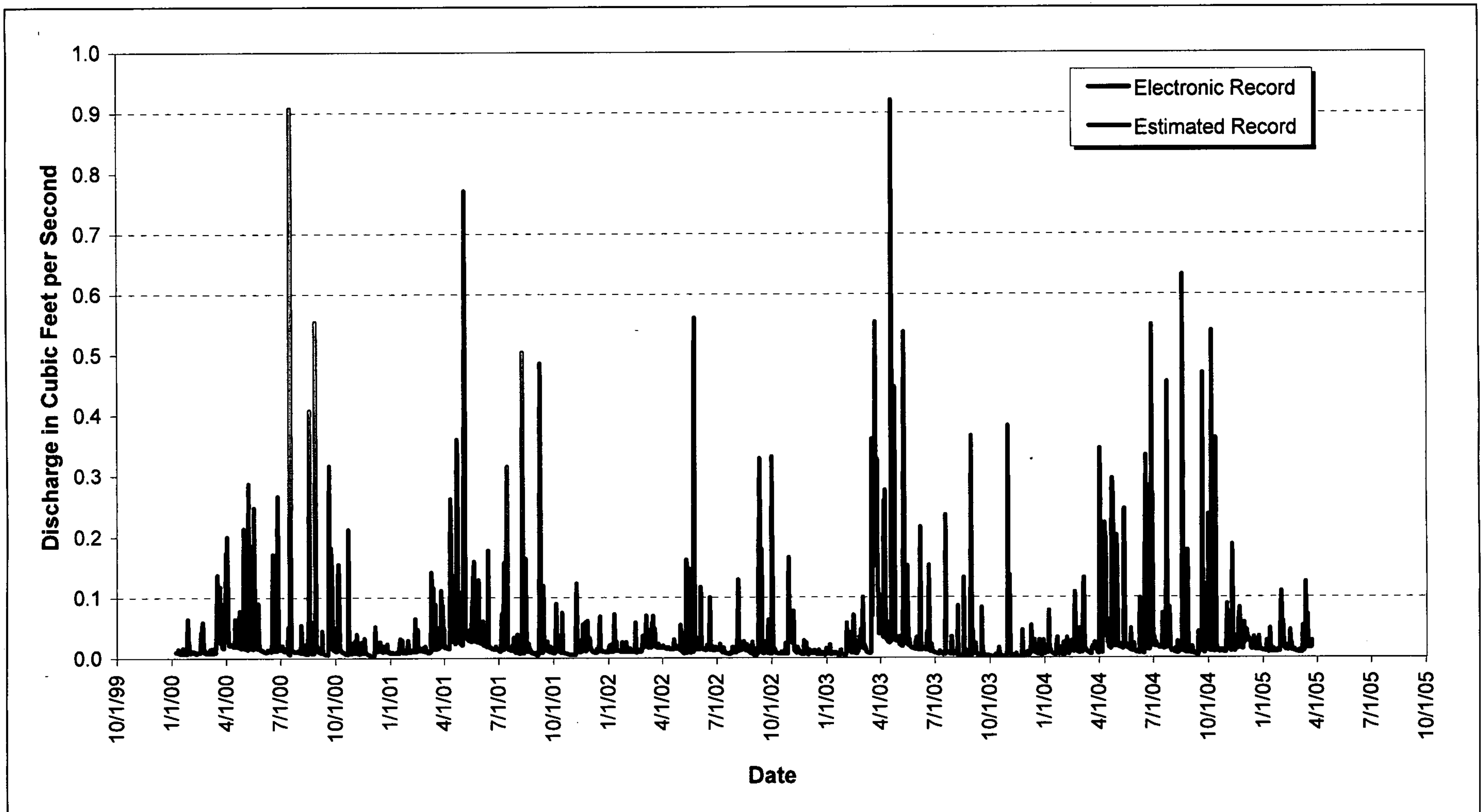


Figure 3-48. WY00-05 Mean Daily Hydrograph at GS22: 400 Area Outfall to SID.

3.2.16 GS28: Ditch NW of B865

Location

Ditch northwest of B865 draining to Central Ave. Ditch; State Plane: E2083072, N749156

Drainage Area

- The basin includes an area surrounding B883 and west of B865 (total of 3.1 acres)
- IA Areas draining to GS28: 800

Period of Record

2/19/02 to 5/3/05 (removed from service)

Gage

Water-stage recorder and 3" Parshall flume

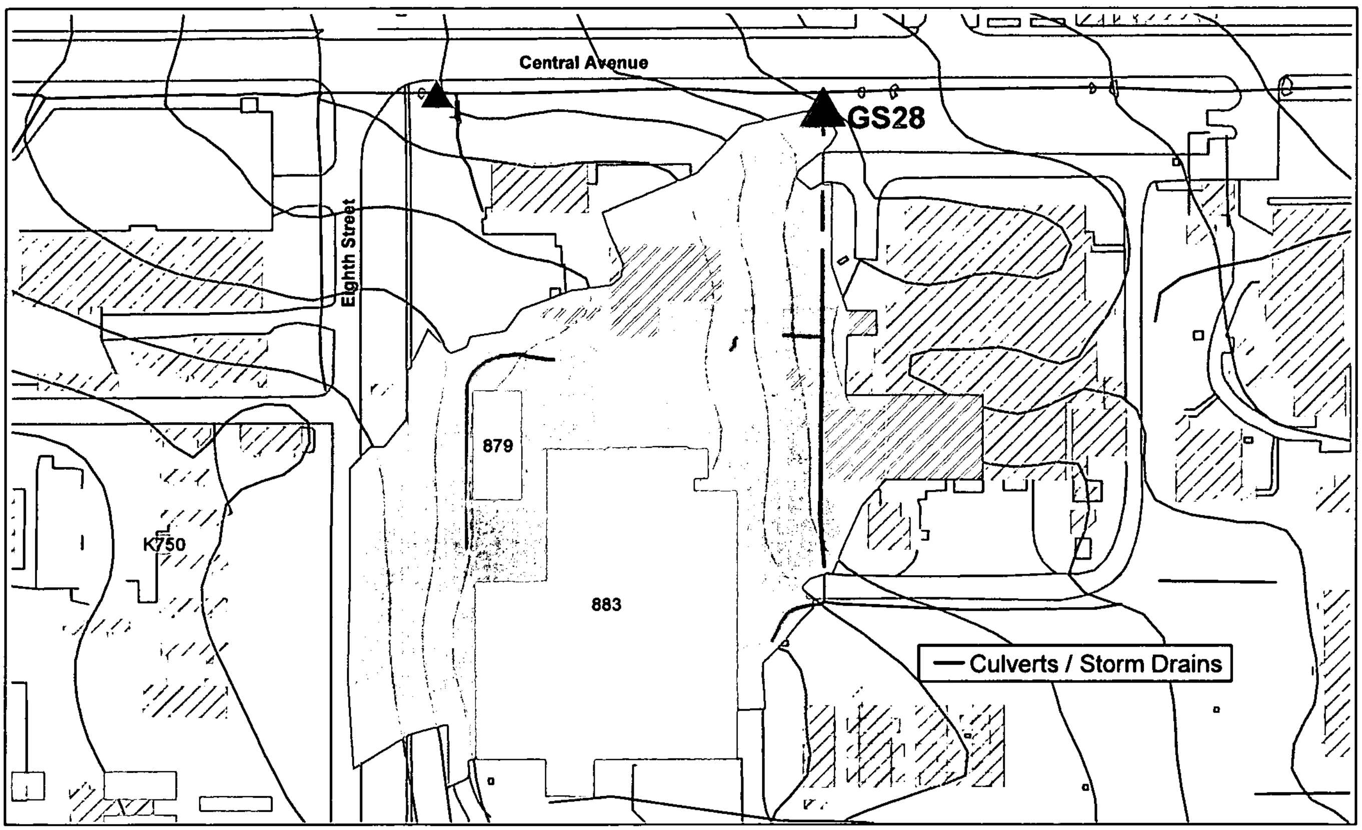


Figure 3-49. Map Showing GS28 Drainage Area.

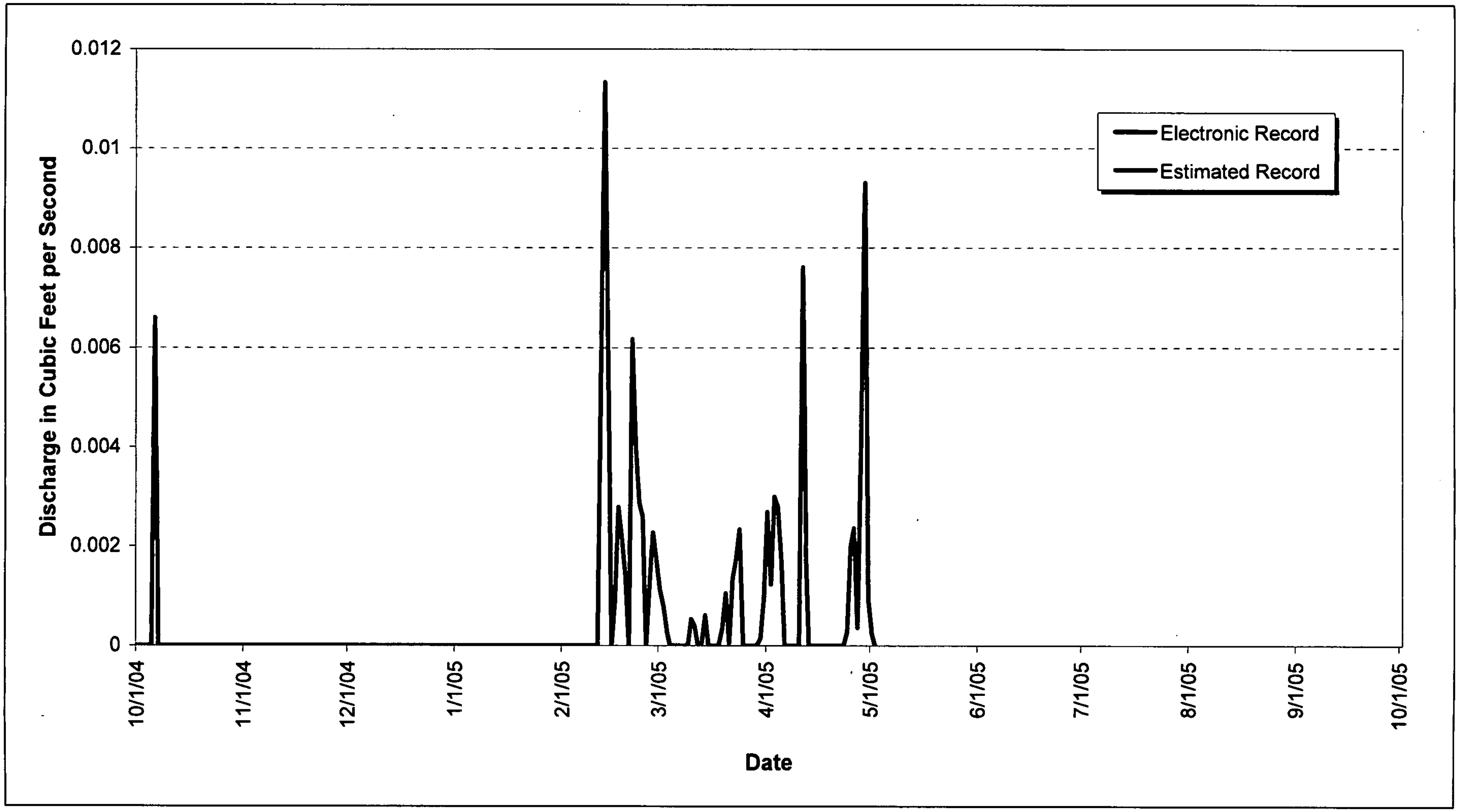


Figure 3-50. WY05 Mean Daily Hydrograph at GS28: Ditch NW of B865.

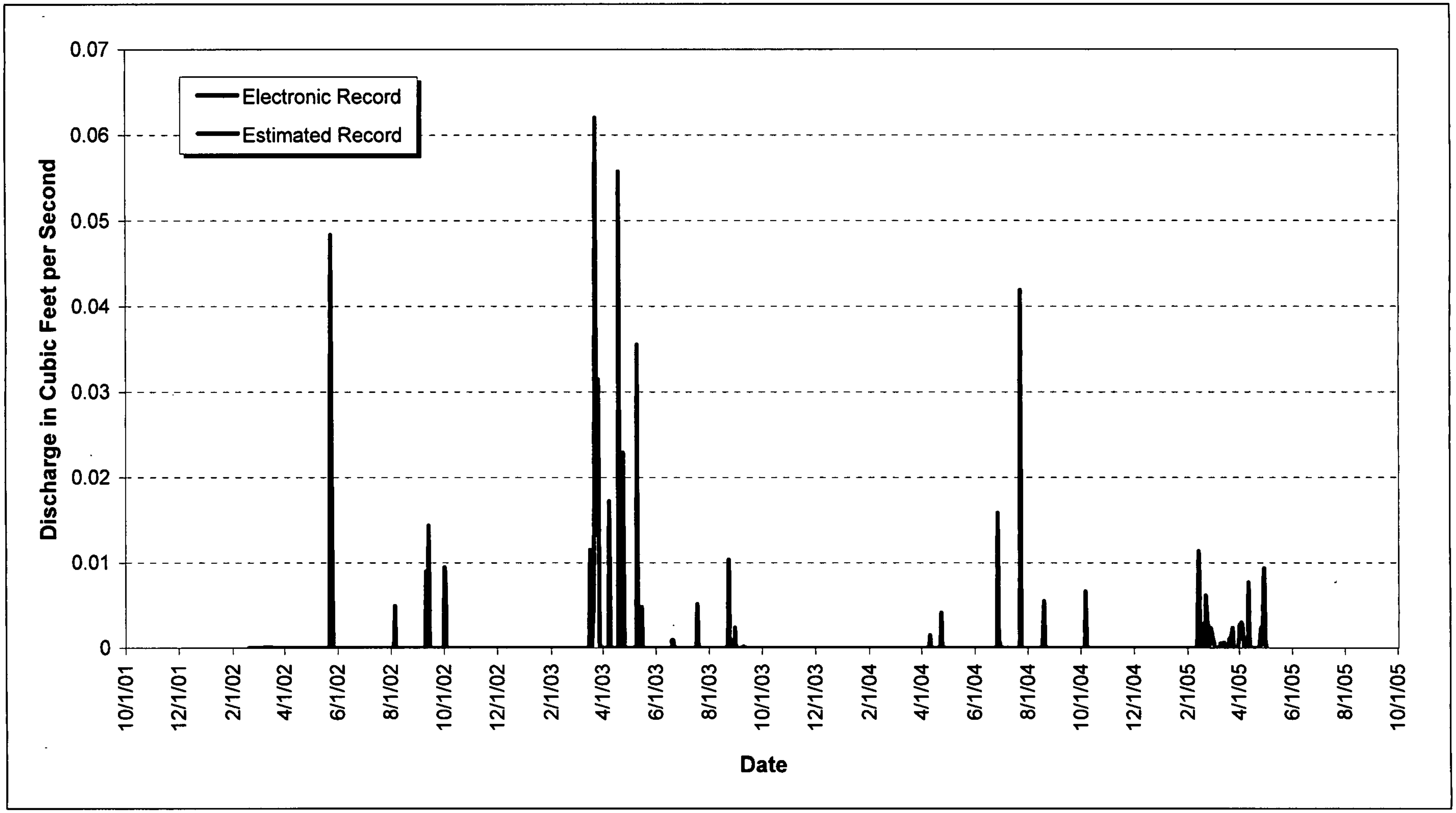


Figure 3-51. WY02-05 Mean Daily Hydrograph at GS28: Ditch NW of B865.

3.2.17 GS31: Woman Creek at Pond C-2 Outlet

Location

Pond C-2 outlet; State Plane: E2089262, N747515

Drainage Area

- The basin includes a portion of the southern IA draining to the SID and the area surrounding Pond C-2 (total of 240.7 acres)
- IA Areas draining to GS31: 900, 800, 600, 400, and 100

Period of Record

10/1/96 to current year

Gage

Water-stage recorder and 24" Parshall flume

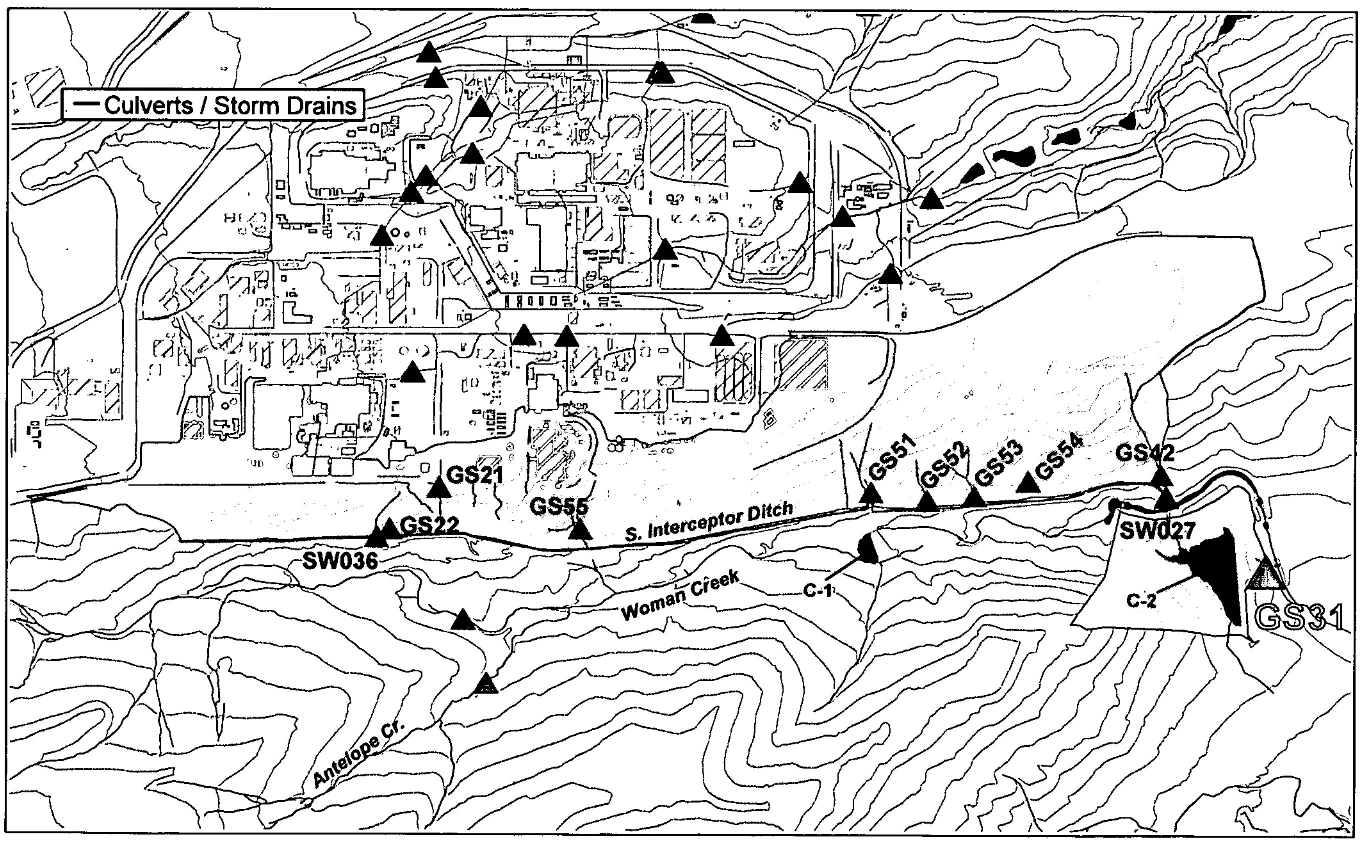


Figure 3-52. Map Showing GS31 Drainage Area.

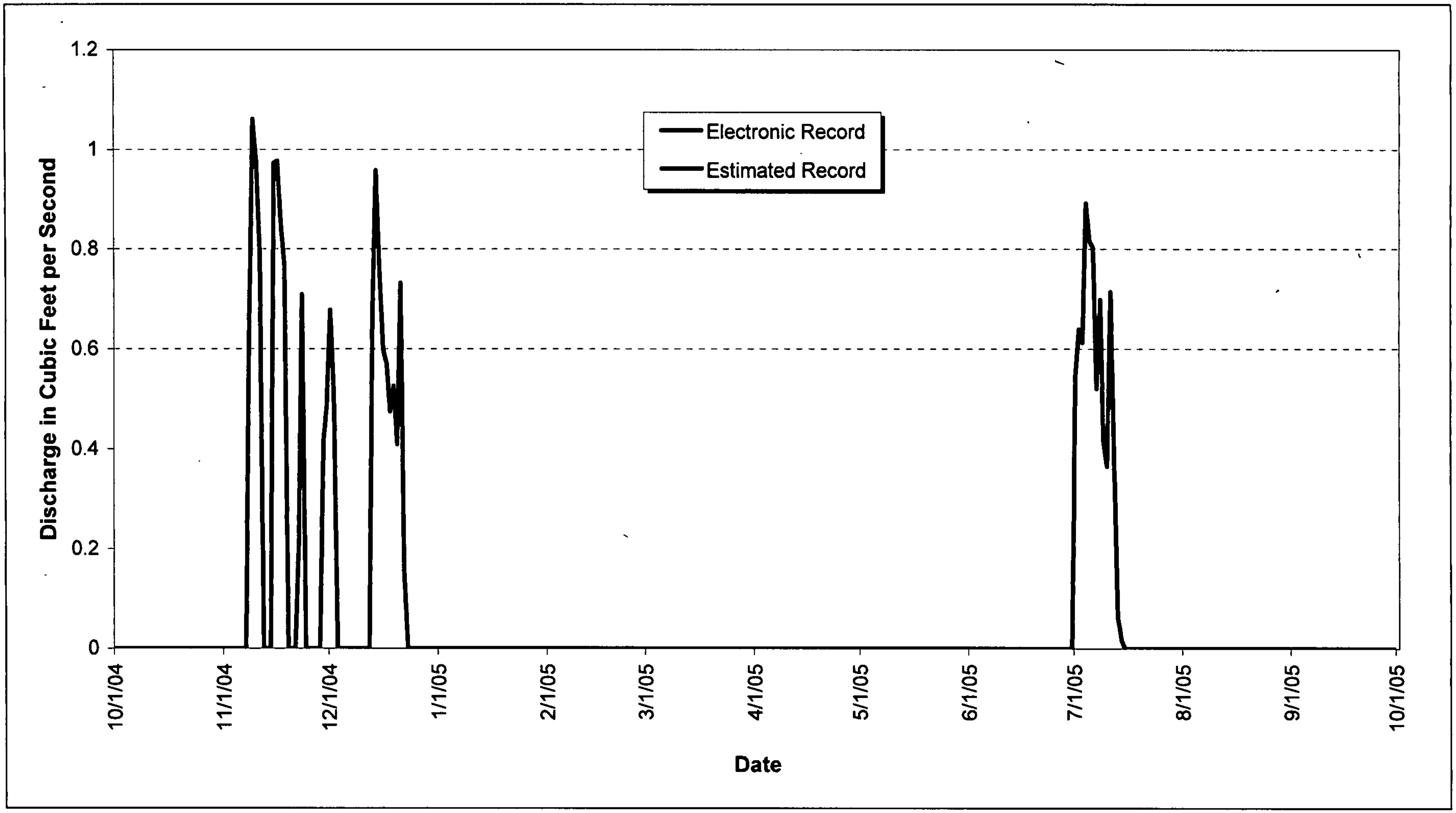


Figure 3-53. WY05 Mean Daily Hydrograph at GS31: Woman Creek at Pond C-2 Outlet.

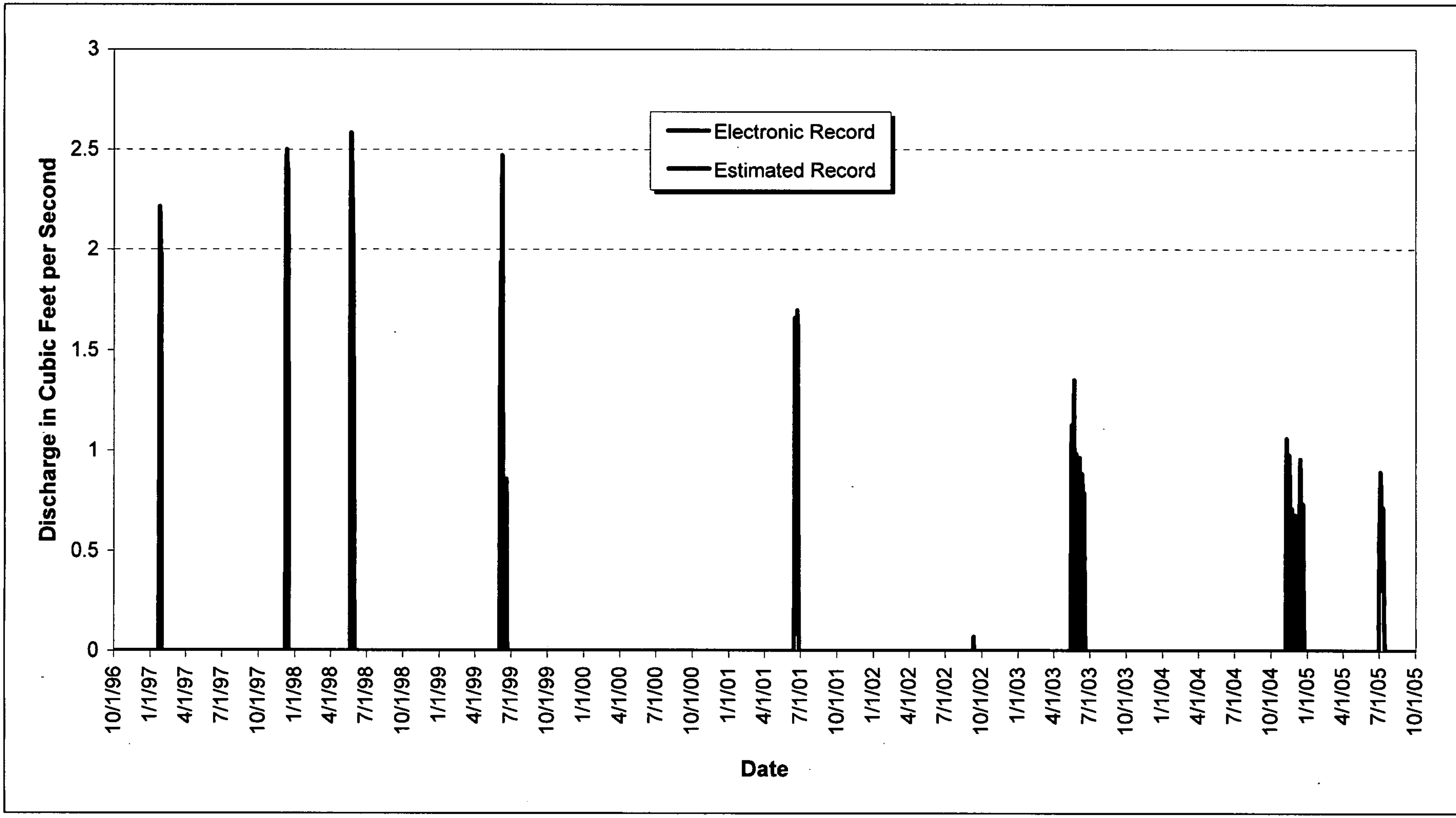


Figure 3-54. WY97-05 Mean Daily Hydrograph at GS31: Woman Creek at Pond C-2 Outlet.

3.2.18 GS32: Building 779 Subdrainage Area

Location

B779 area outfall; State Plane: E2084700, N751262

Drainage Area

- The basin includes the B779 subdrainage (total of 6.9 acres)
- IA Areas draining to GS32: 700

Period of Record

1/31/97 to 3/1/05 (removed from service)

Gage

No flow measurement at GS32

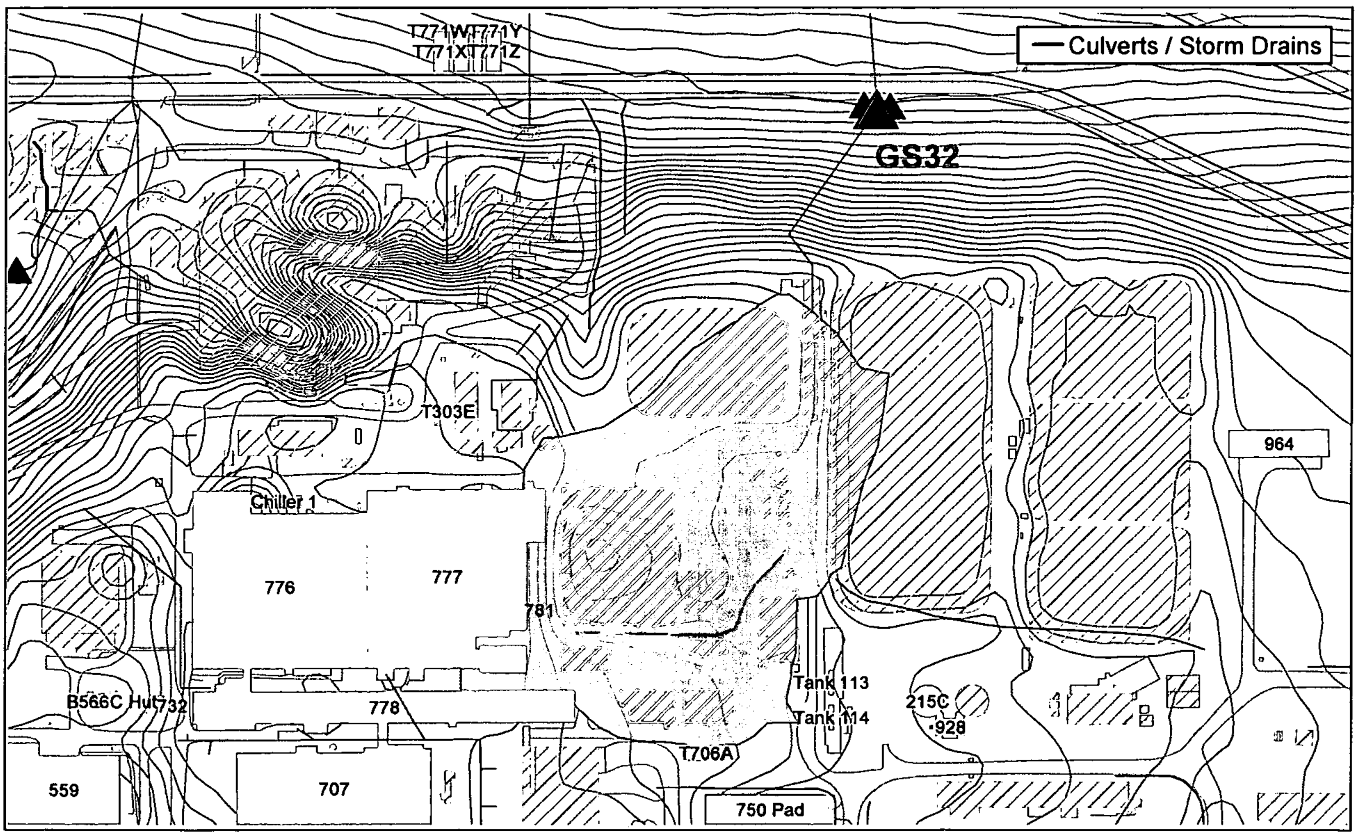


Figure 3-55. Map Showing GS32 Drainage Area.

3.2.19 GS33: No Name Gulch at Walnut Creek

Location

No Name Gulch at Walnut Creek; State Plane: E2090209, N753621

Drainage Area

- The basin is the No Name Gulch drainage not including the Landfill Pond which is pump transferred to the A-Series Ponds (total of 258.5 acres)
- IA Areas draining to GS33: none

Period of Record

9/16/97 to current year

Gage

Water-stage recorder and 9.5" Parshall flume

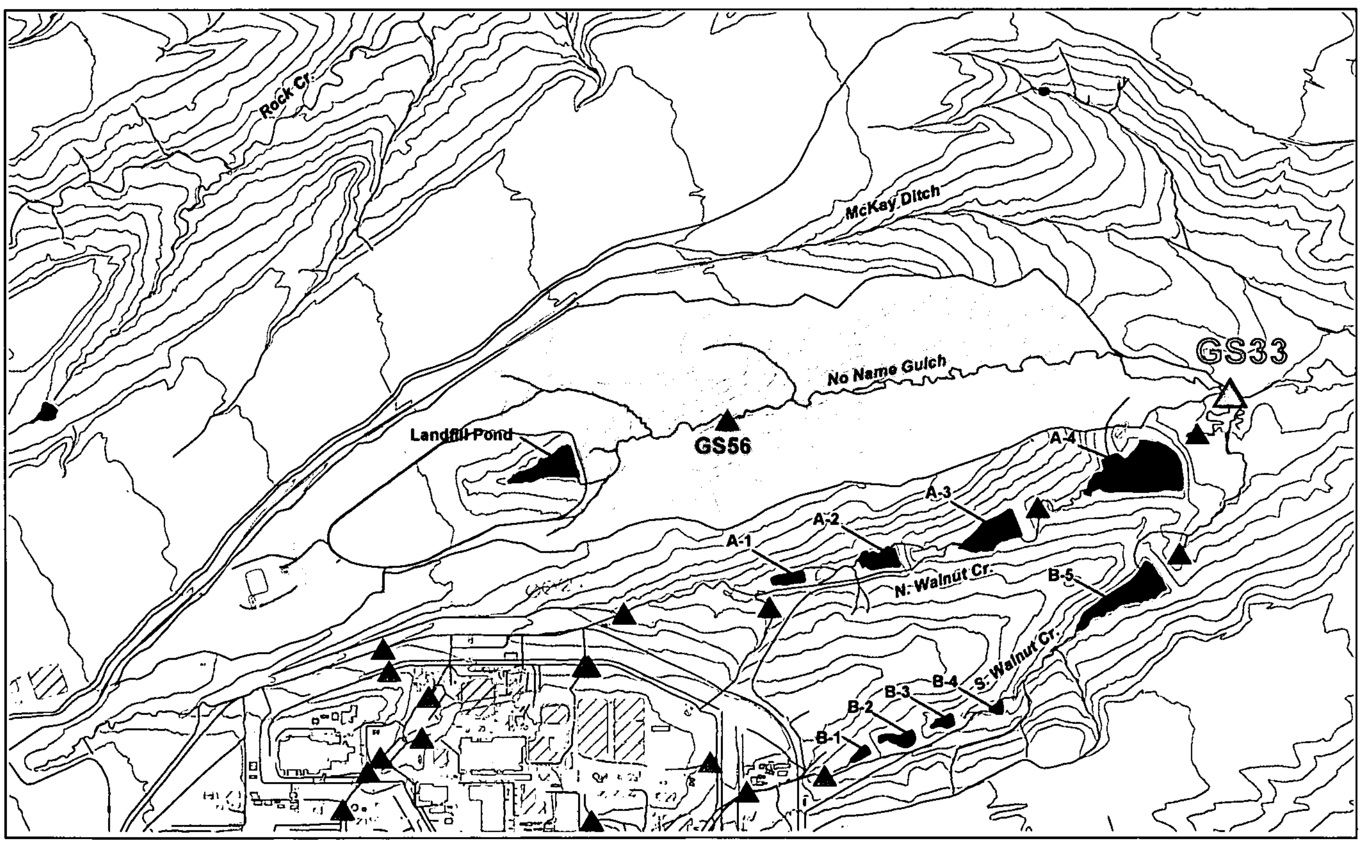


Figure 3-56. Map Showing GS33 Drainage Area.

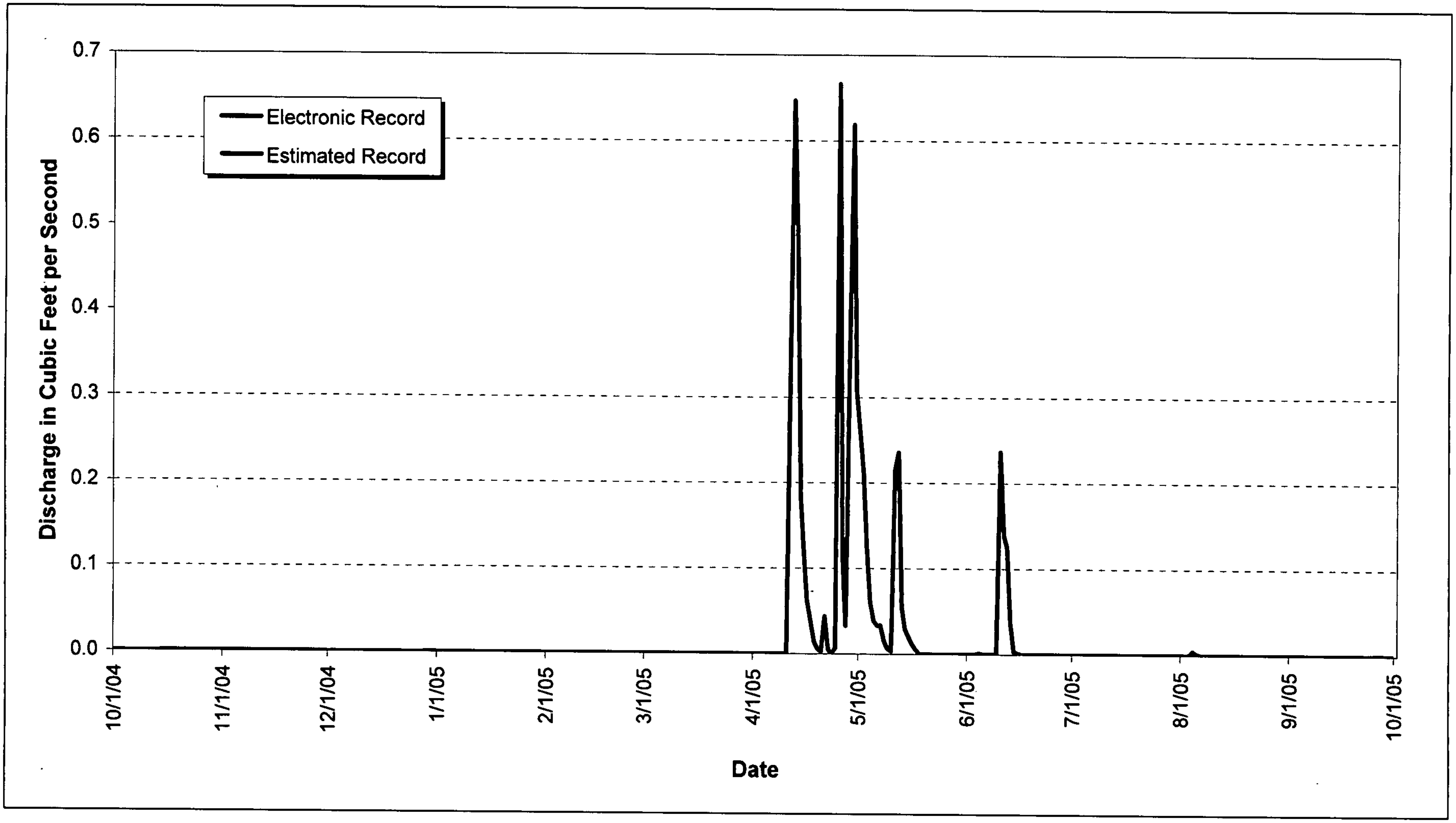


Figure 3-57. WY05 Mean Daily Hydrograph at GS33: No Name Gulch at Walnut Creek.

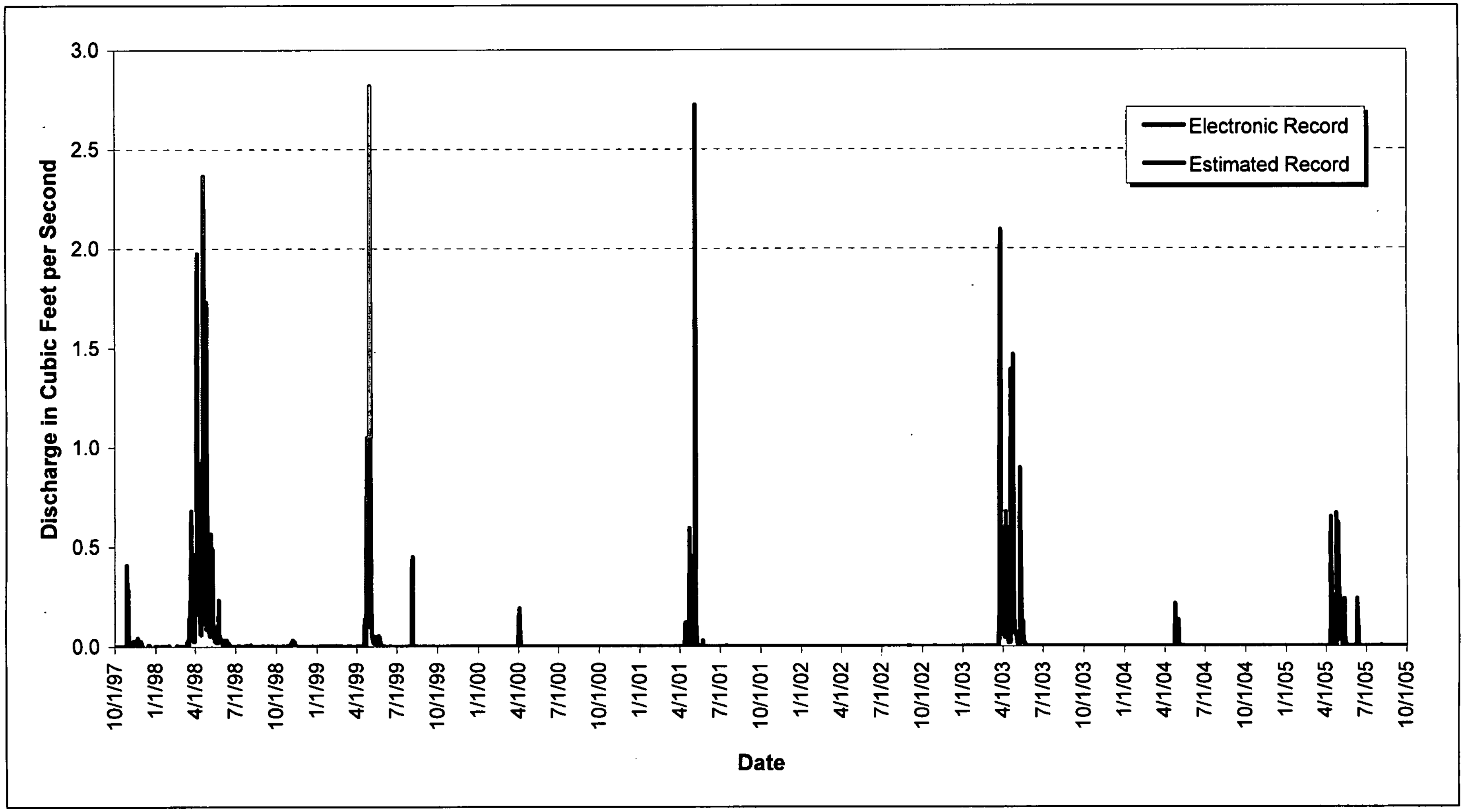


Figure 3-58. WY98-05 Mean Daily Hydrograph at GS33: No Name Gulch at Walnut Creek.

3.2.20 GS38: Central Avenue Ditch at Eighth Street

Location

Central Avenue Ditch at Eighth Street; State Plane: E2083684, N749289

Drainage Area

- The basin includes a portion of the southwestern IA (total of 40.7 acres)
- IA Areas draining to GS38: 600, 400, and 100

Period of Record

1/28/98 to 6/6/05 (removed from service)

Gage

Water-stage recorder and 9.5" Parshall flume

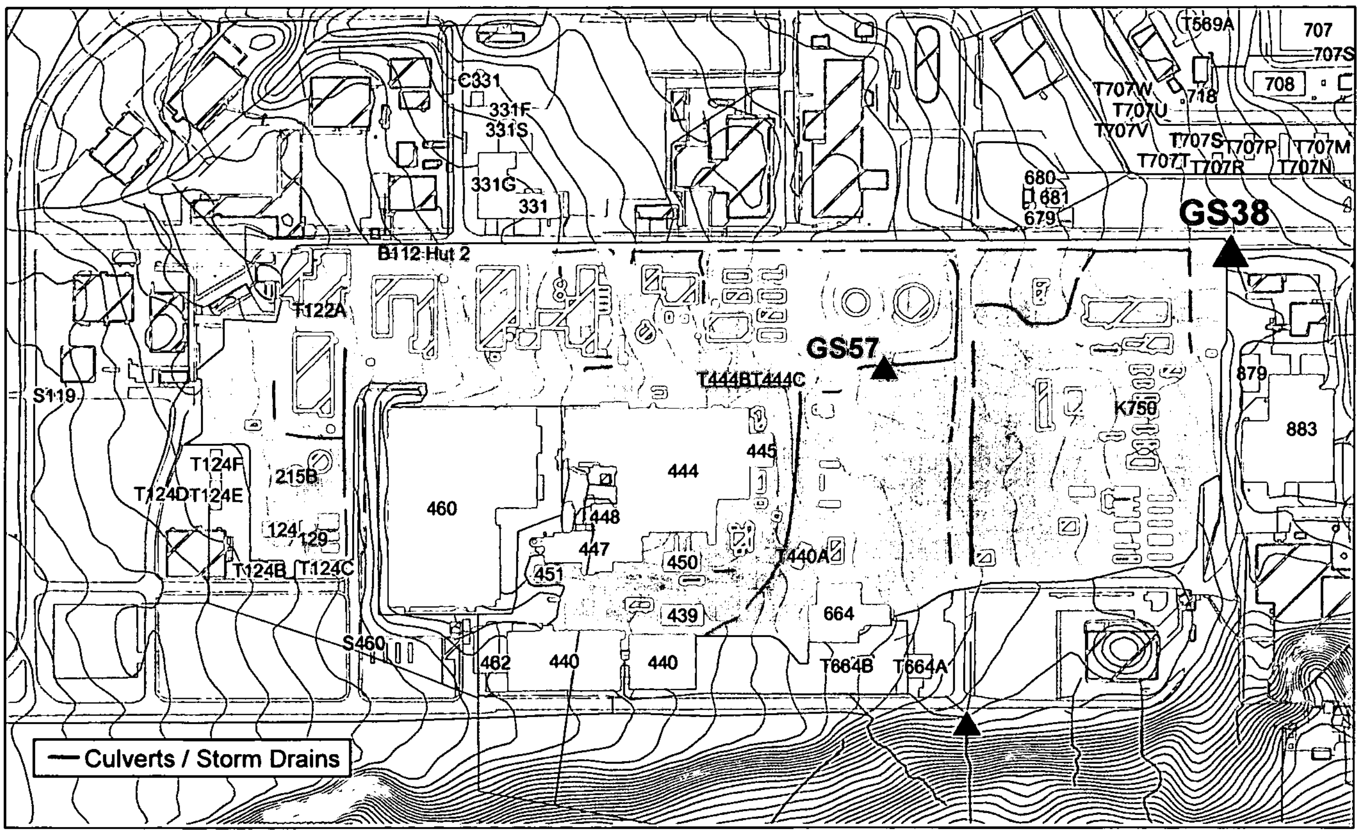


Figure 3-59. Map Showing GS38 Drainage Area.

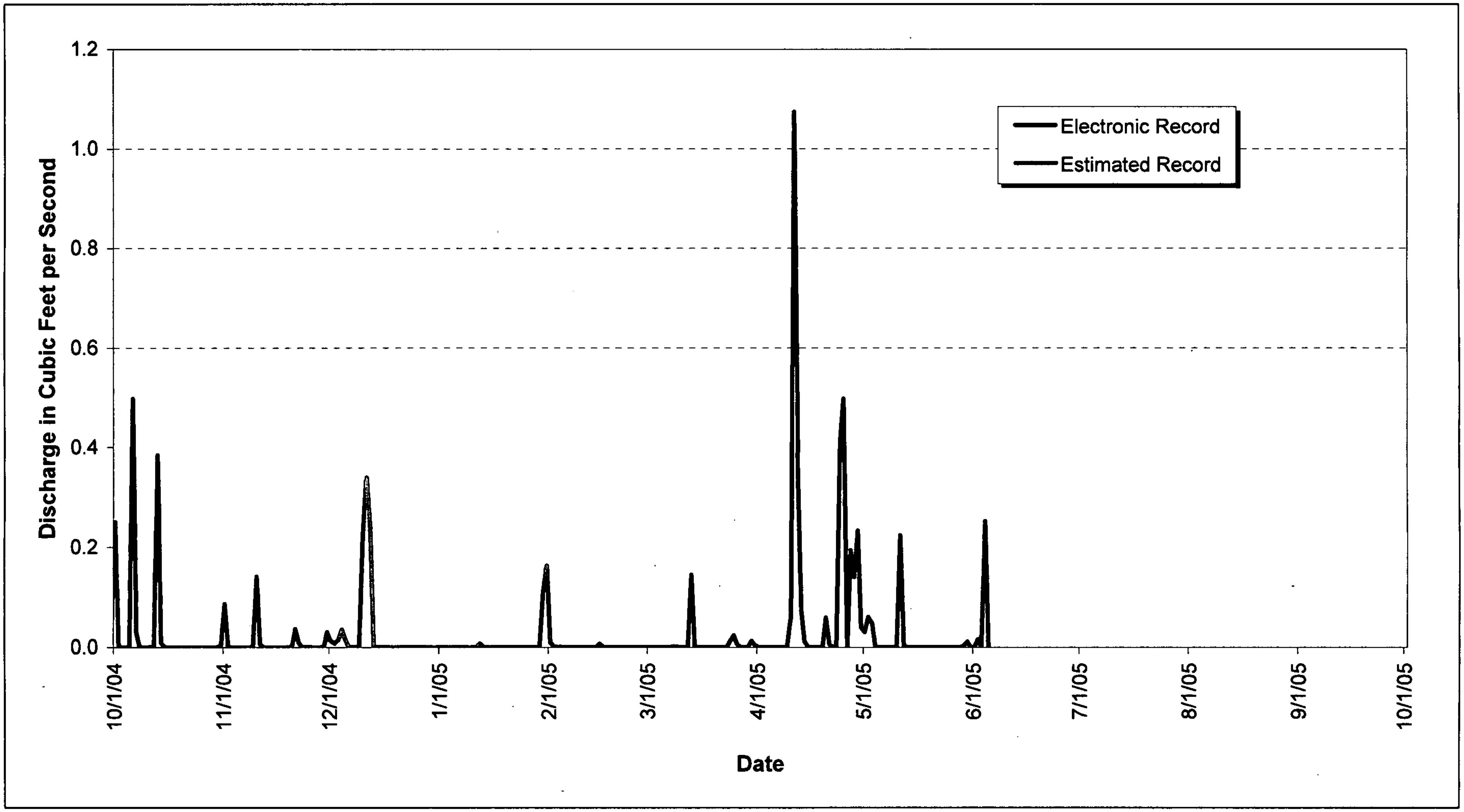


Figure 3-60. WY05 Mean Daily Hydrograph at GS38: Central Avenue Ditch at Eighth Street.

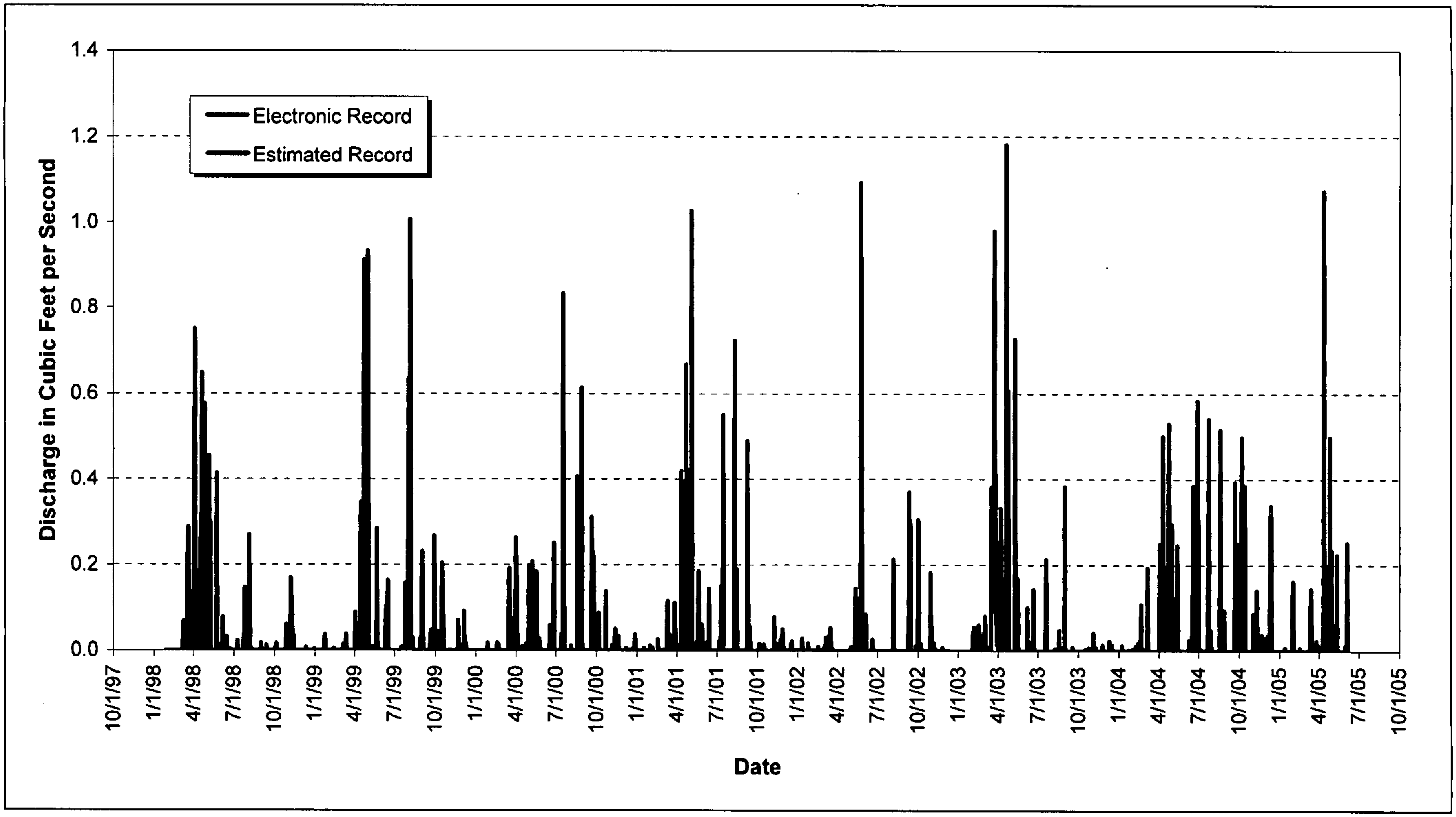


Figure 3-61. WY98-05 Mean Daily Hydrograph at GS38: Central Avenue Ditch at Eighth Street.

3.2.21 GS39: 903/904 Pad Subdrainage Area

Location

Ditch northwest of 903 Pad; State Plane: E2085175, N749286

Drainage Area

- The basin includes a portion of the Contractor Yard, the 904 Pad, and the west side of the 903 Pad (total of 8.1 acres)
- IA Areas draining to GS39: 900

Period of Record

1/15/98 to 5/17/05 (removed from service)

Gage

Water-stage recorder and 1' H-flume

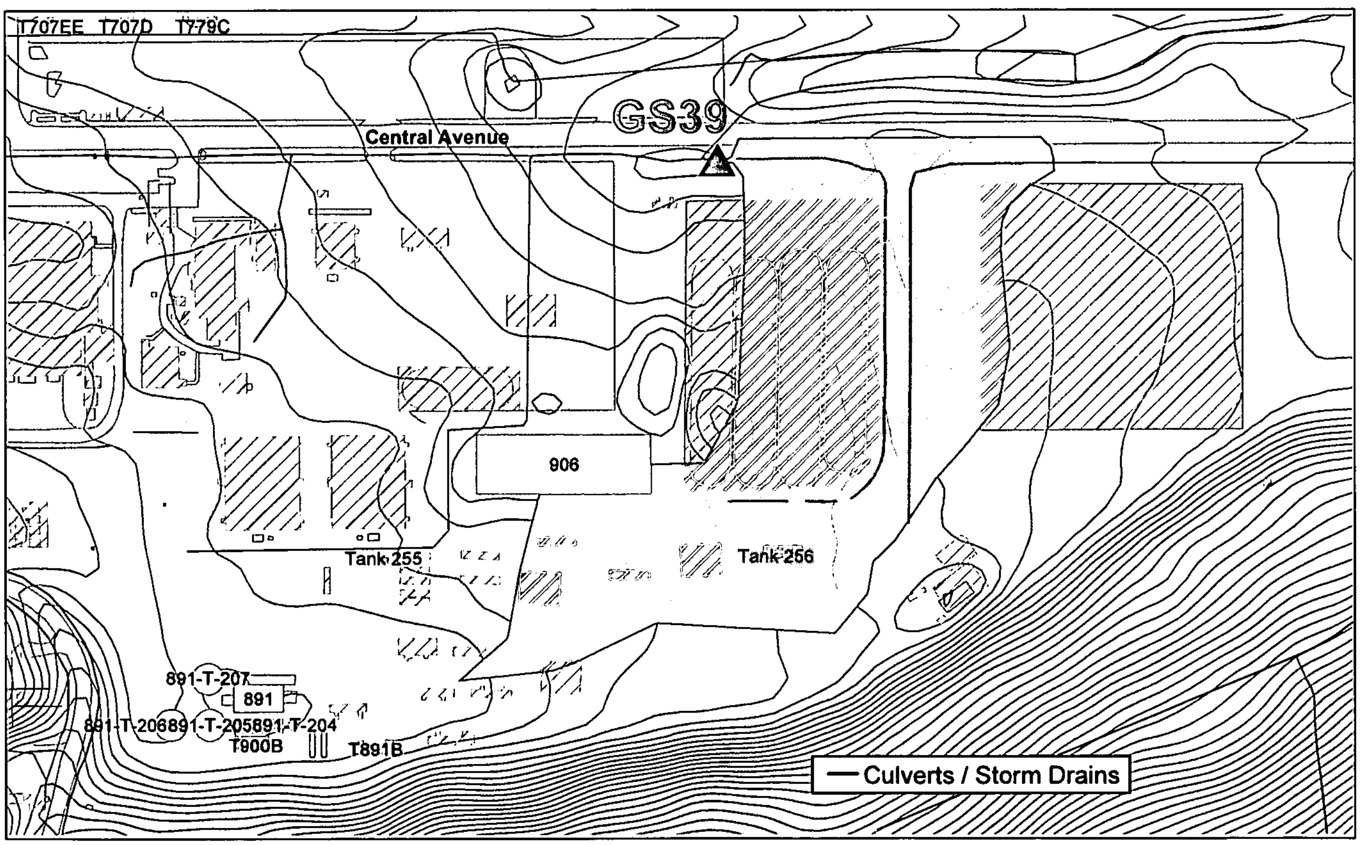


Figure 3-62. Map Showing GS39 Drainage Area.

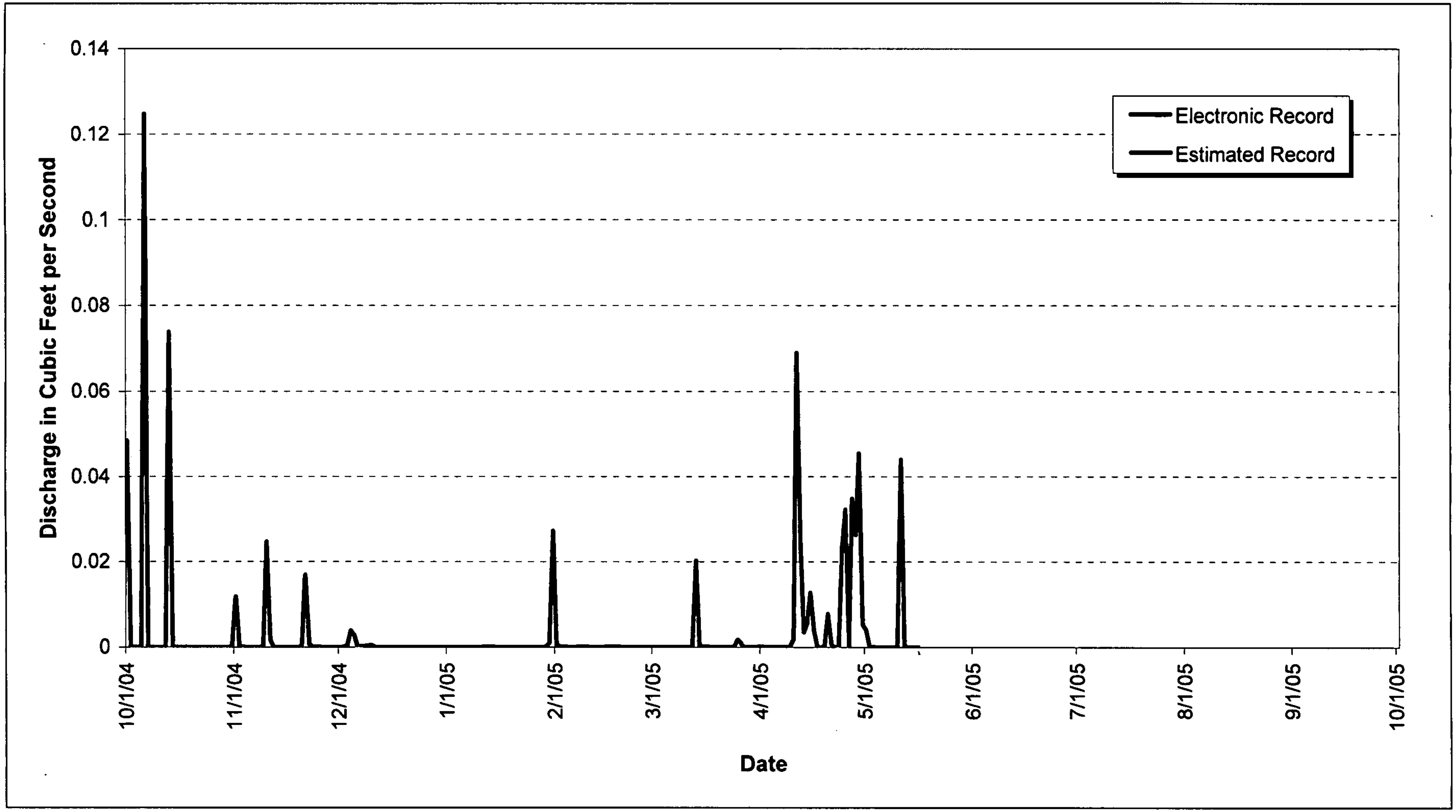


Figure 3-63. WY05 Mean Daily Hydrograph at GS39: 903/904 Pad Subdrainage Area.

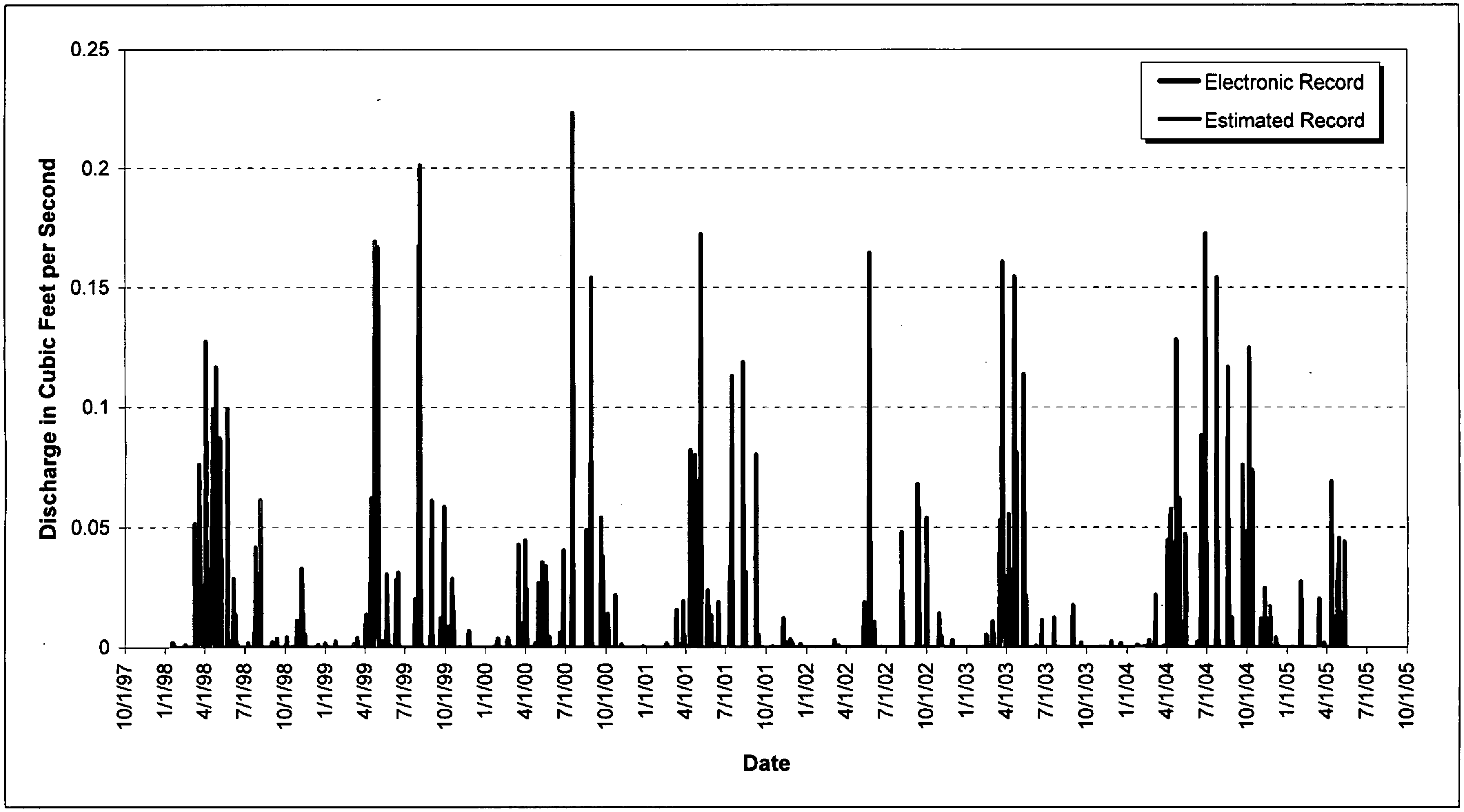


Figure 3-64. WY98-05 Mean Daily Hydrograph at GS39: 903/904 Pad Subdrainage Area.

3.2.22 GS40: South Walnut Creek East of 750 Pad

Location

700 Area outfall to North Walnut Creek east of 750 Pad; State Plane: E2084748, N749938

Drainage Area

- The basin includes a portion of the 700 Area inside the PA (total of 24.4 acres)
- IA Areas draining to GS40: 700

Period of Record

3/4/98 to 8/3/05 (removed from service)

Gage

Water-stage recorder and 1' Parshall flume

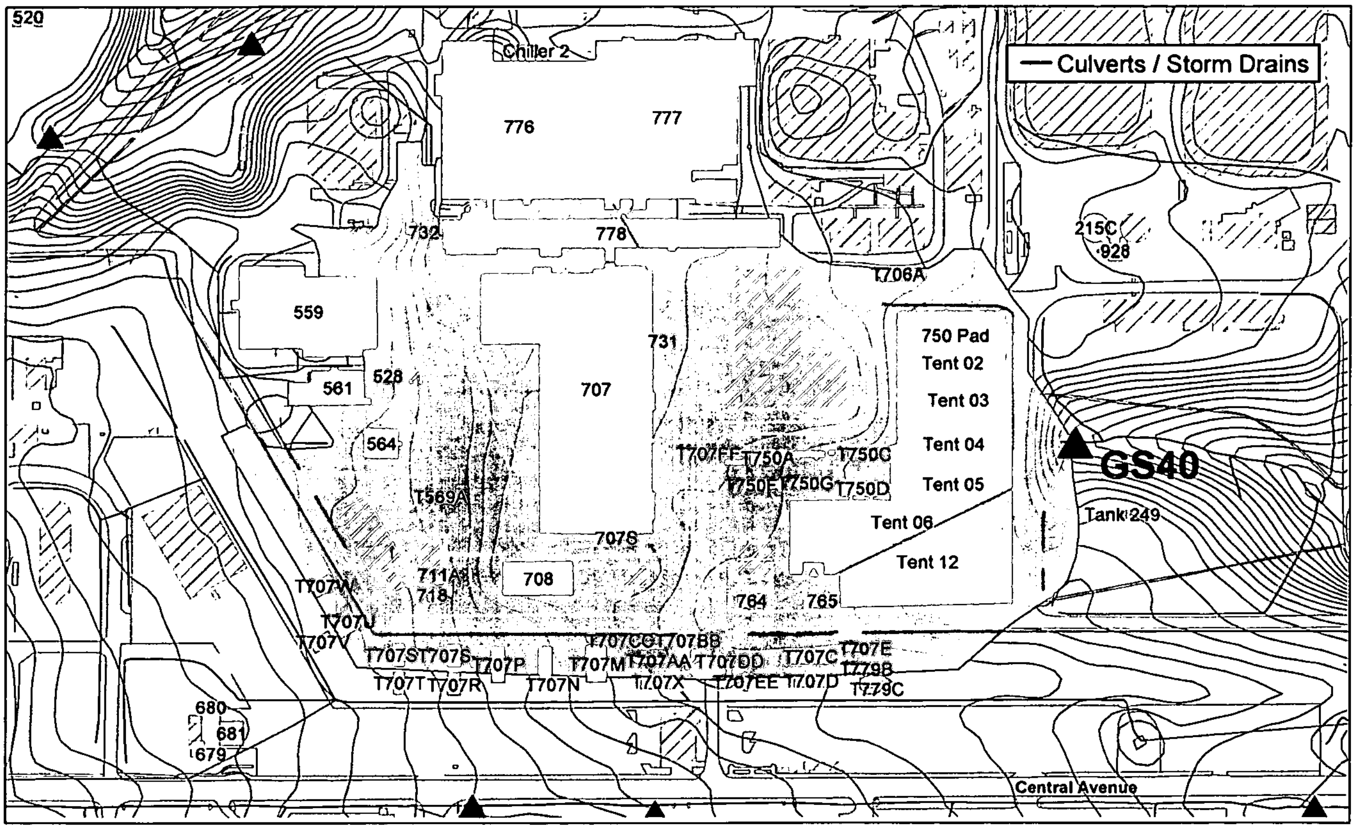


Figure 3-65. Map Showing GS40 Drainage Area.

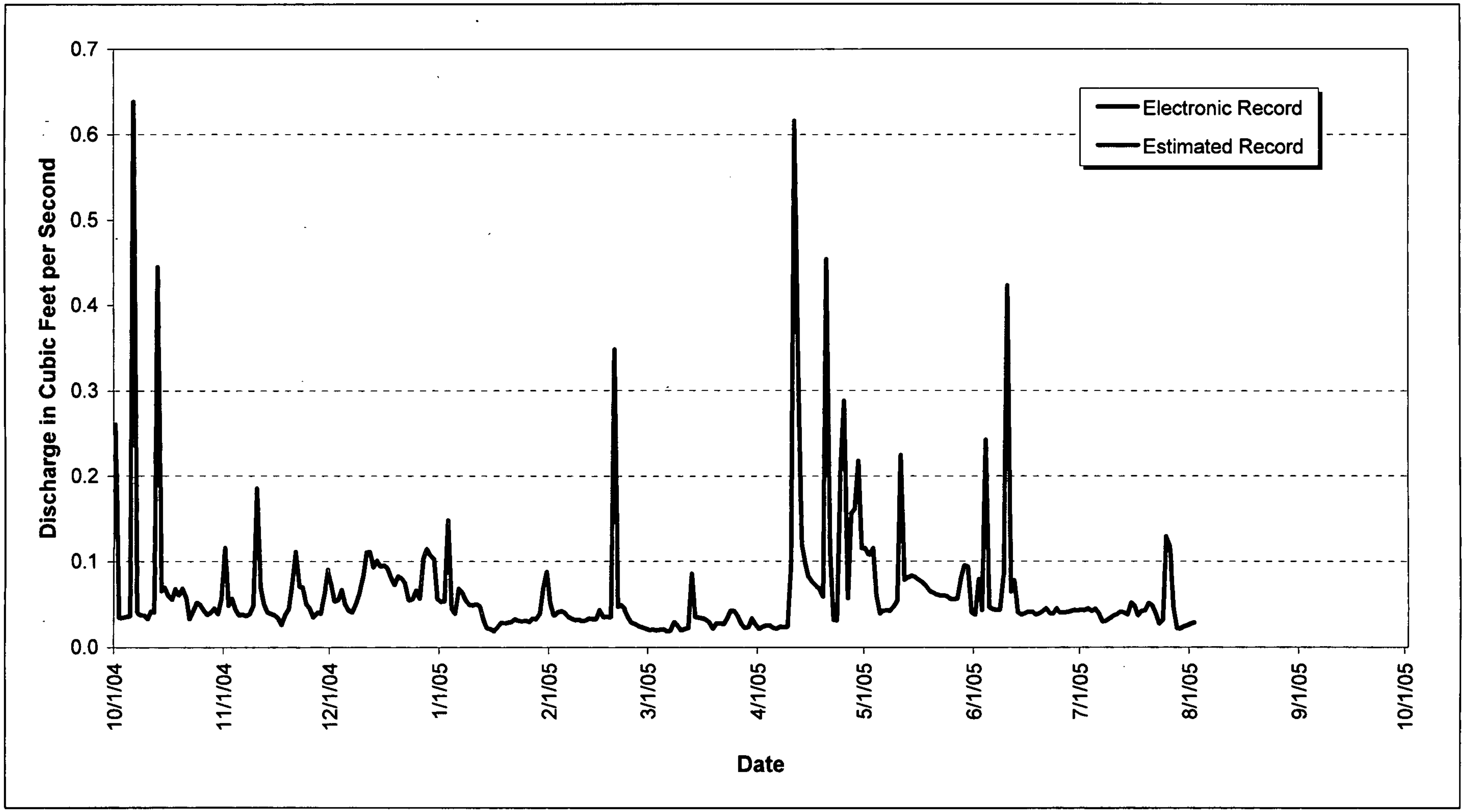


Figure 3-66. WY05 Mean Daily Hydrograph at GS40: South Walnut Creek East of 750 Pad.

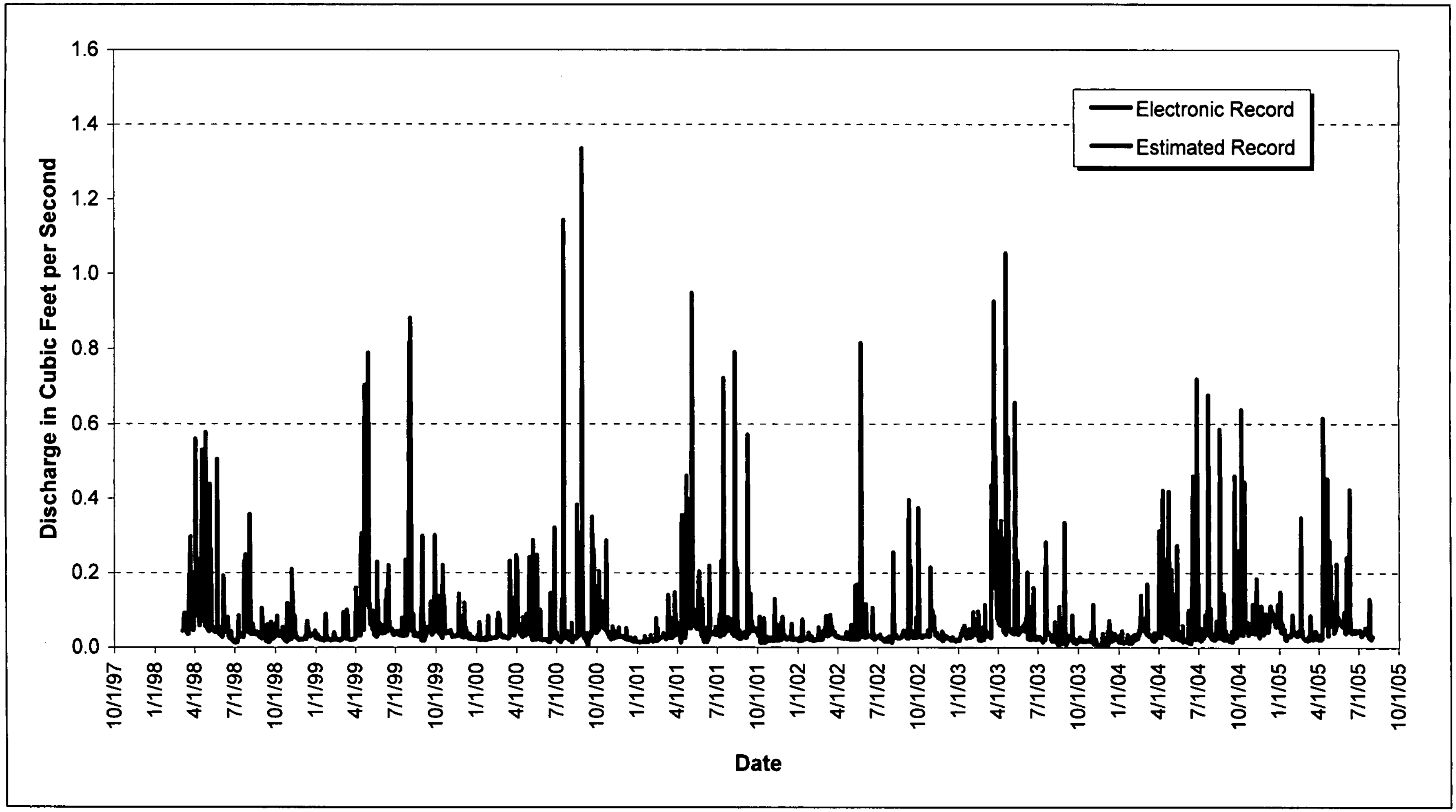


Figure 3-67. WY98-05 Mean Daily Hydrograph at GS40: South Walnut Creek East of 750 Pad.

3.2.23 GS42: Unnamed Gulch Tributary to the SID North of SW027

Location

Unnamed gulch tributary to the SID north of SW027; State Plane: E2088476, N748237

Drainage Area

- The basin includes a portion of the West Access Road (total of 45.2 acres)
- IA Areas draining to GS42: none

Period of Record

6/23/98 to 9/7/05 (removed from service)

Gage

Water-stage recorder and 3" Parshall flume

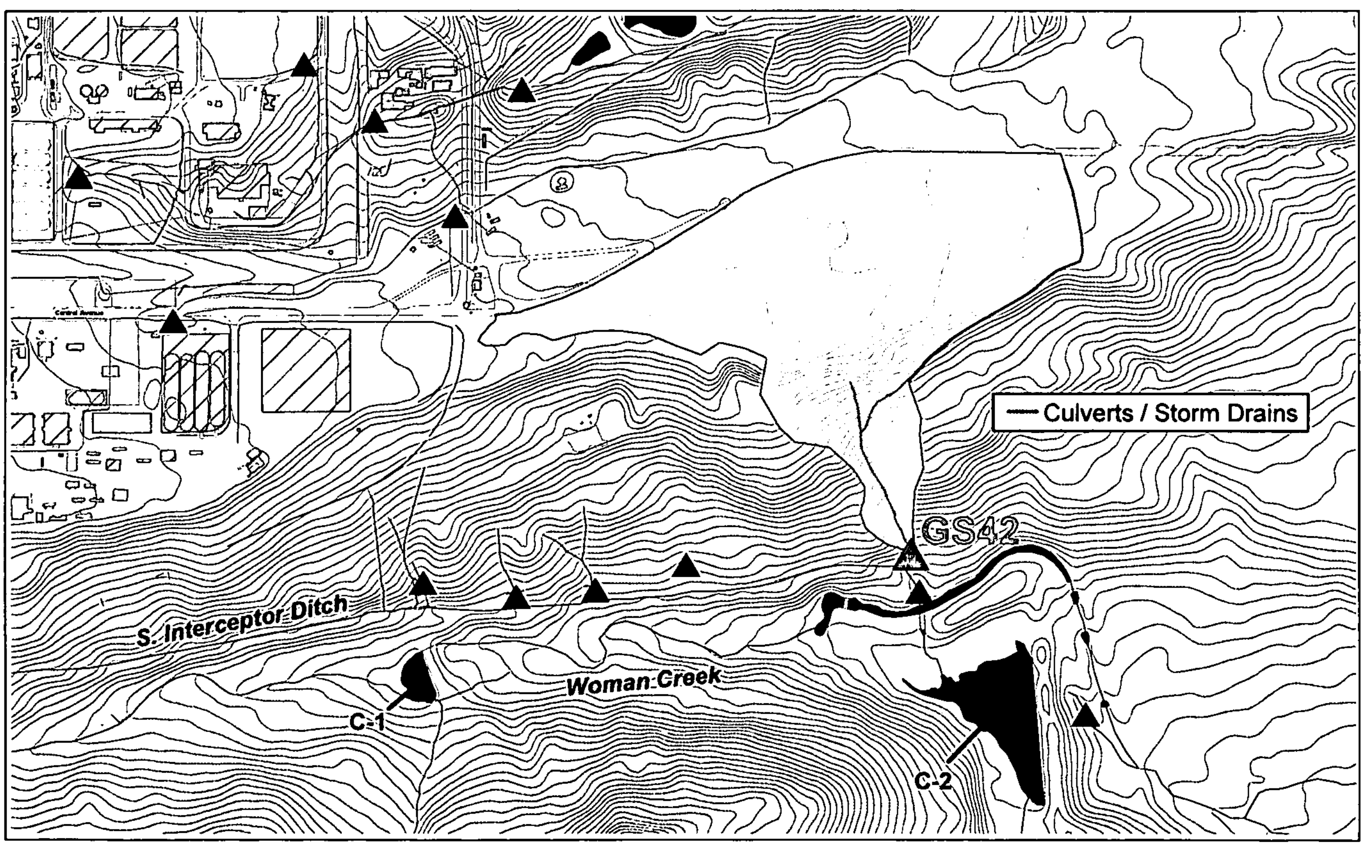


Figure 3-68. Map Showing GS42 Drainage Area.

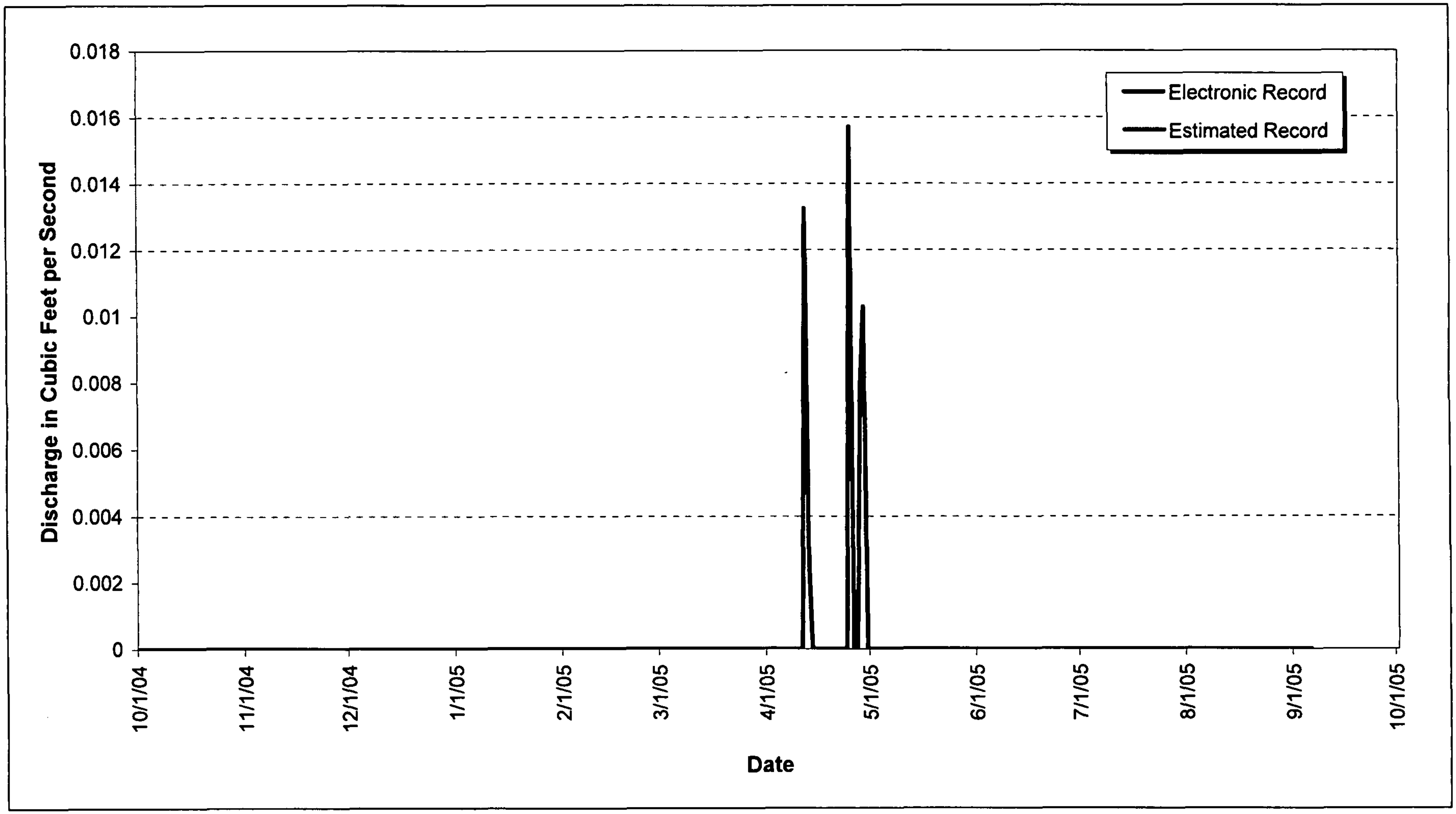


Figure 3-69. WY05 Mean Daily Hydrograph at GS42: Unnamed Gulch Tributary to SID.

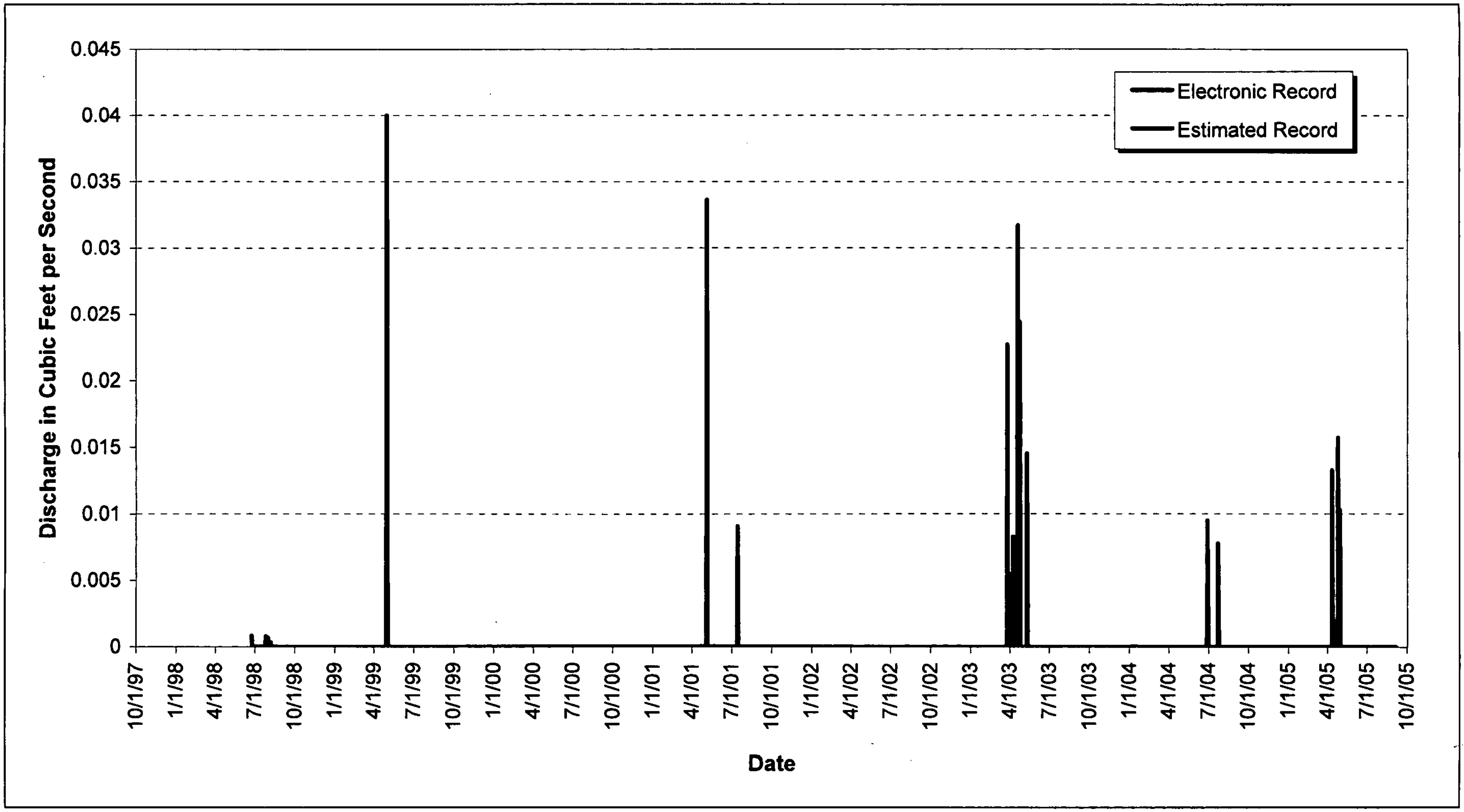


Figure 3-70. WY98-05 Mean Daily Hydrograph at GS42: Unnamed Gulch Tributary to SID.

3.2.24 GS49: Ditch Northwest of B566

Location

Ditch northwest of B566; State Plane: E2083292, N750652

Drainage Area

- The basin includes areas on west side of B776 (total of 3.3 acres)
- IA Areas draining to GS49: 500, 700

Period of Record

12/29/00 to 8/30/05 (removed from service)

Gage

Water-stage recorder and 6" Parshall flume

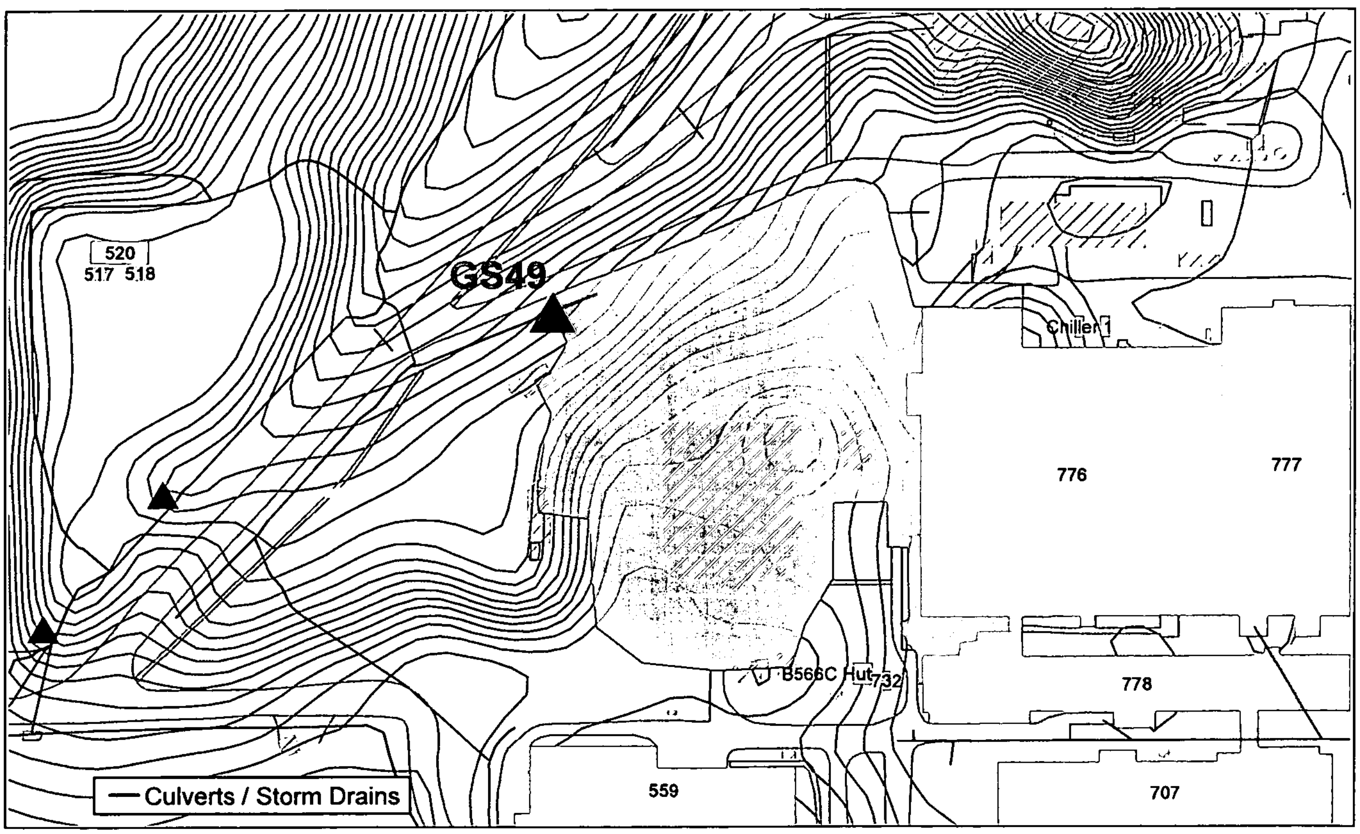


Figure 3-71. Map Showing GS49 Drainage Area.

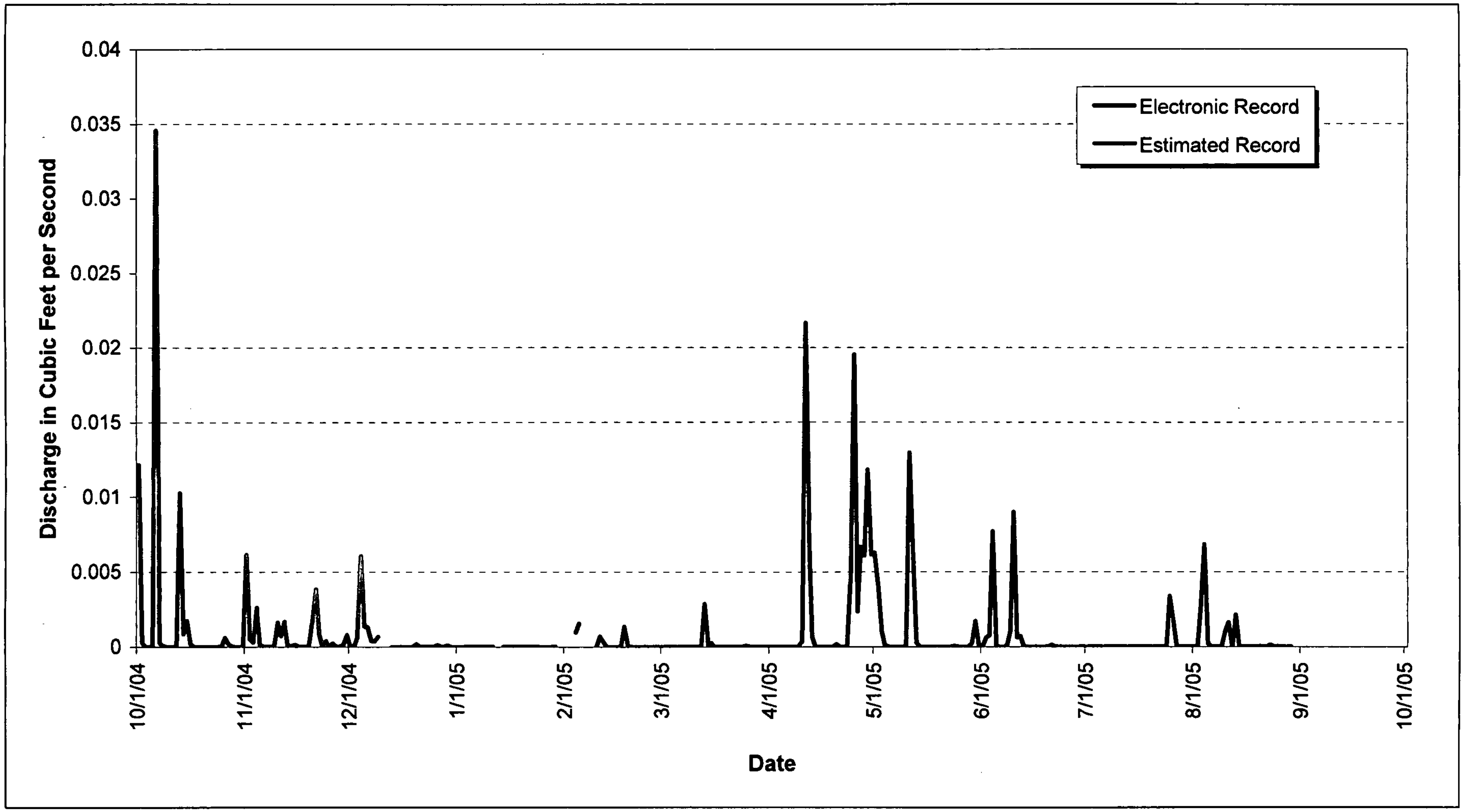


Figure 3-72. WY05 Mean Daily Hydrograph at GS49: Ditch Northwest of B566.

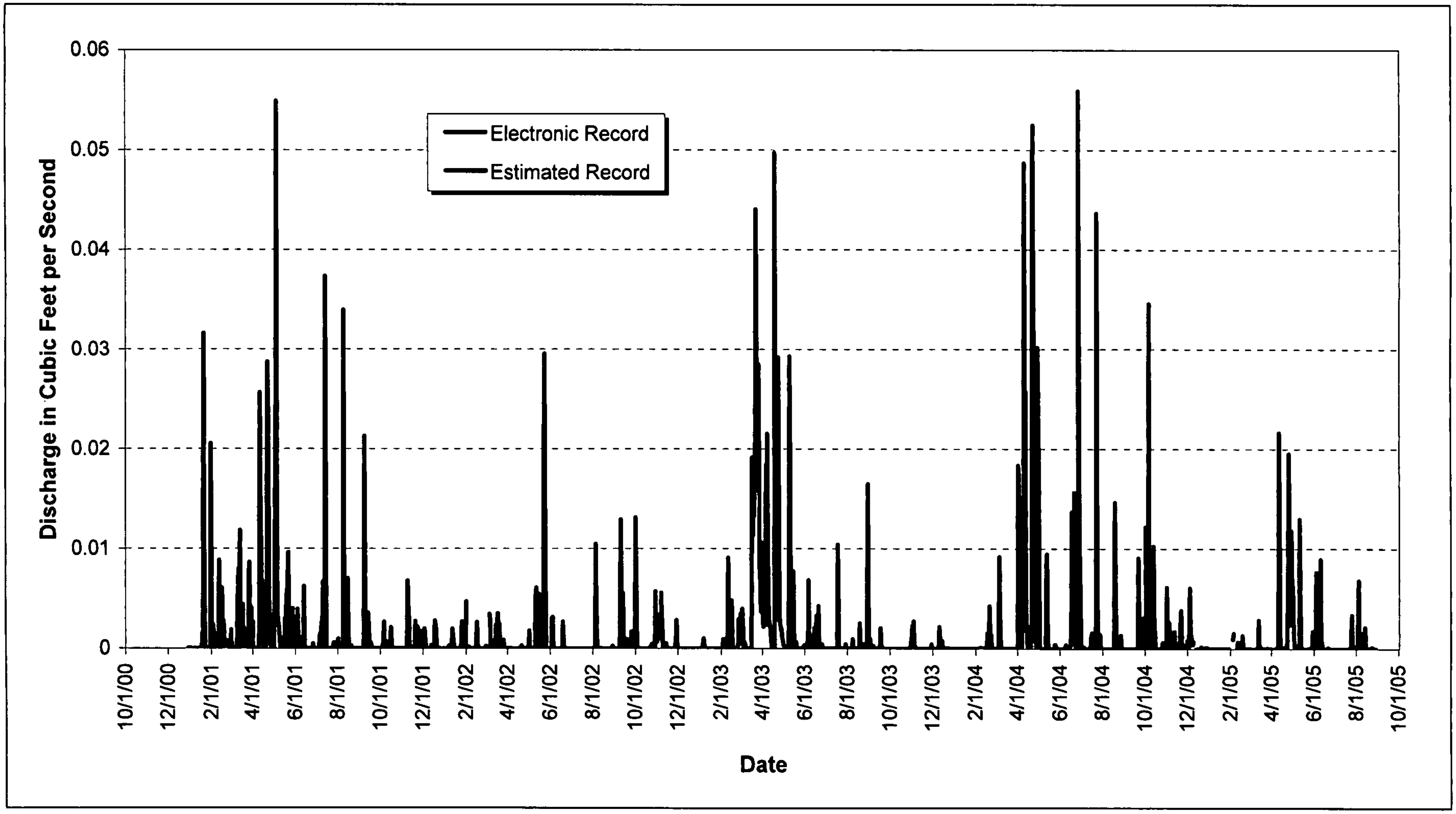


Figure 3-73. WY01-05 Mean Daily Hydrograph at GS49: Ditch Northwest of B566.

3.2.25 GS50: Ditch Northeast of B990

Location

Ditch northeast of B990; State Plane: E2085760, N750441

Drainage Area

- The basin includes areas surrounding the Solar Ponds (total of 9.3 acres)
- IA Areas draining to GS50: 700, 900

Period of Record

3/28/01 to 3/22/05 (removed from service)

Gage

Water-stage recorder and 6" Parshall flume

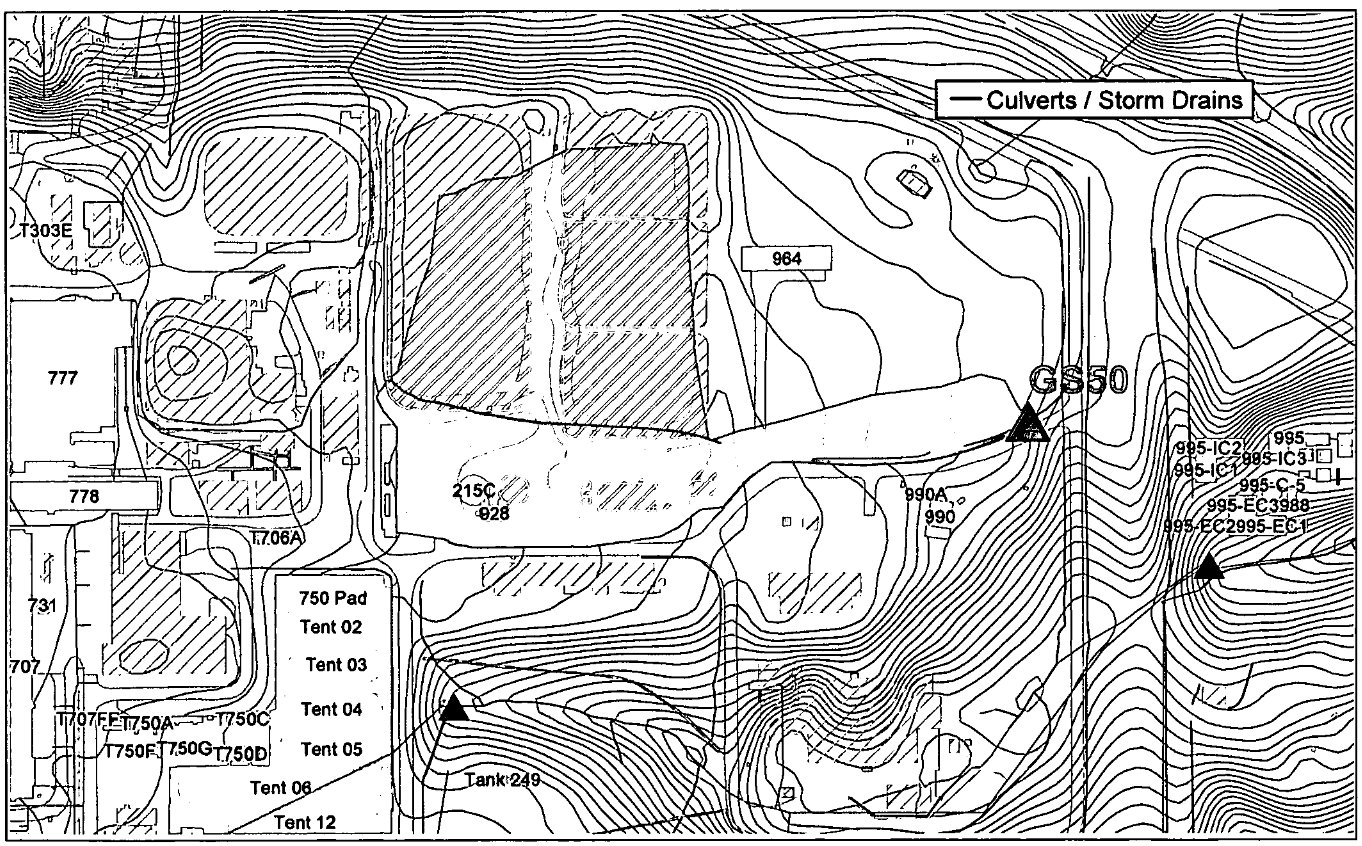


Figure 3-74. Map Showing GS50 Drainage Area.

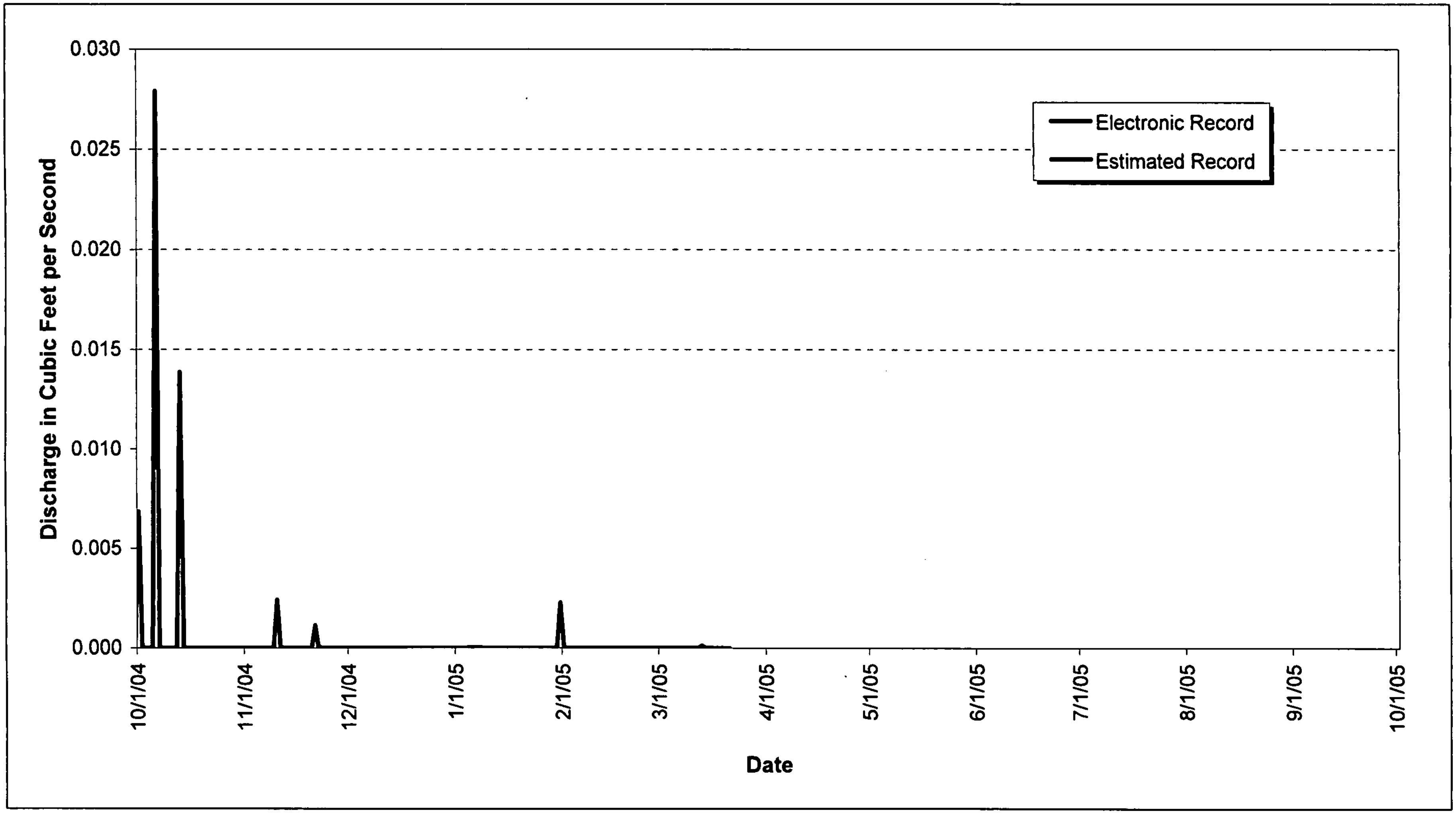


Figure 3-75. WY05 Mean Daily Hydrograph at GS50: Ditch Northeast of B990.

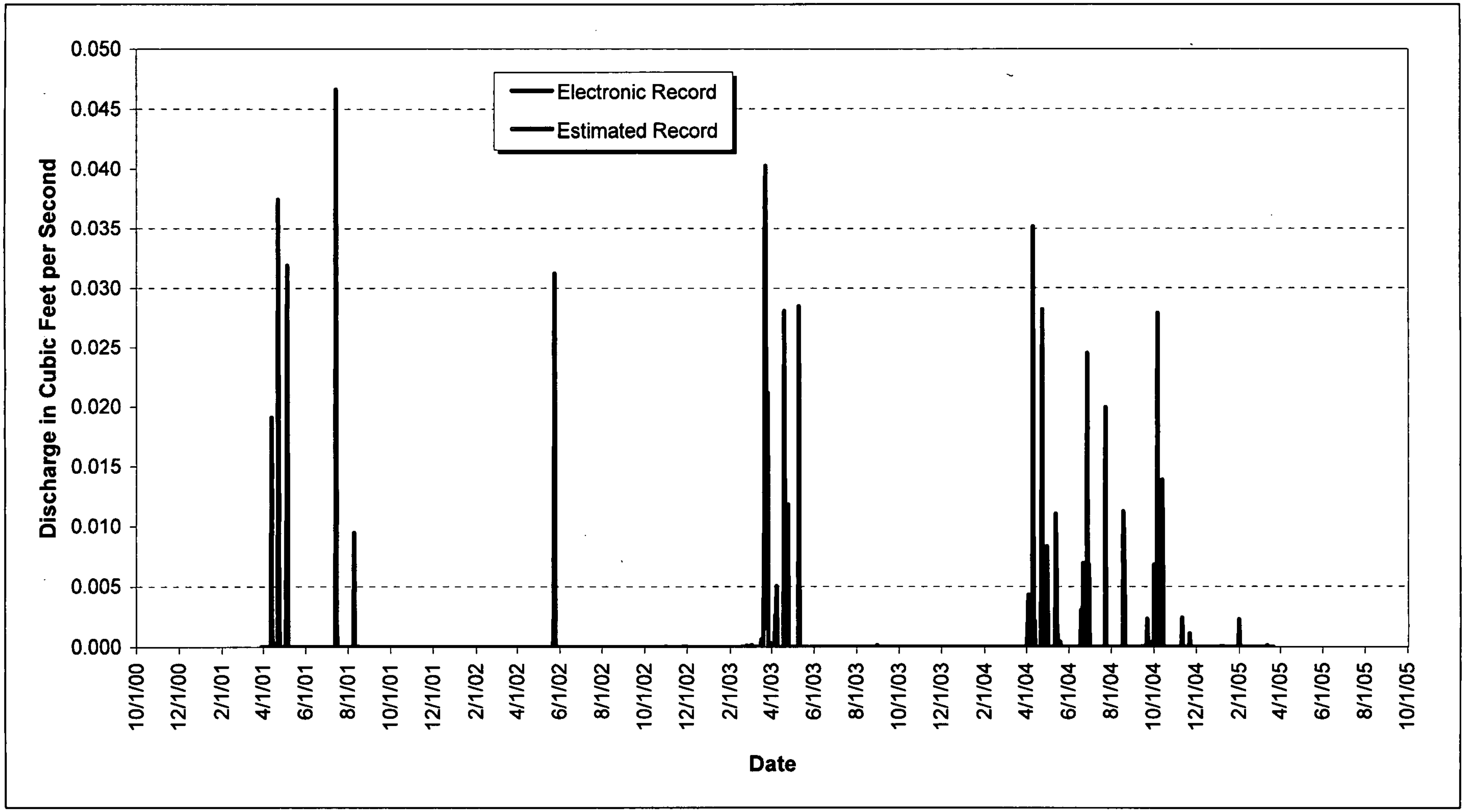


Figure 3-76. WY01-05 Mean Daily Hydrograph at GS50: Ditch Northeast of B990.

3.2.26 GS51: Ditch South of 903 Pad

Location

Ditch south of 903 Pad; State Plane: E2086295, N748107

Drainage Area

- The basin includes an area south and east of the 903 Pad (total of 21.6 acres after 903 Pad/Lip completion)
- IA Areas draining to GS51: 900

Period of Record

8/13/01 to current year

Gage

Water-stage recorder and 0.75' H-flume

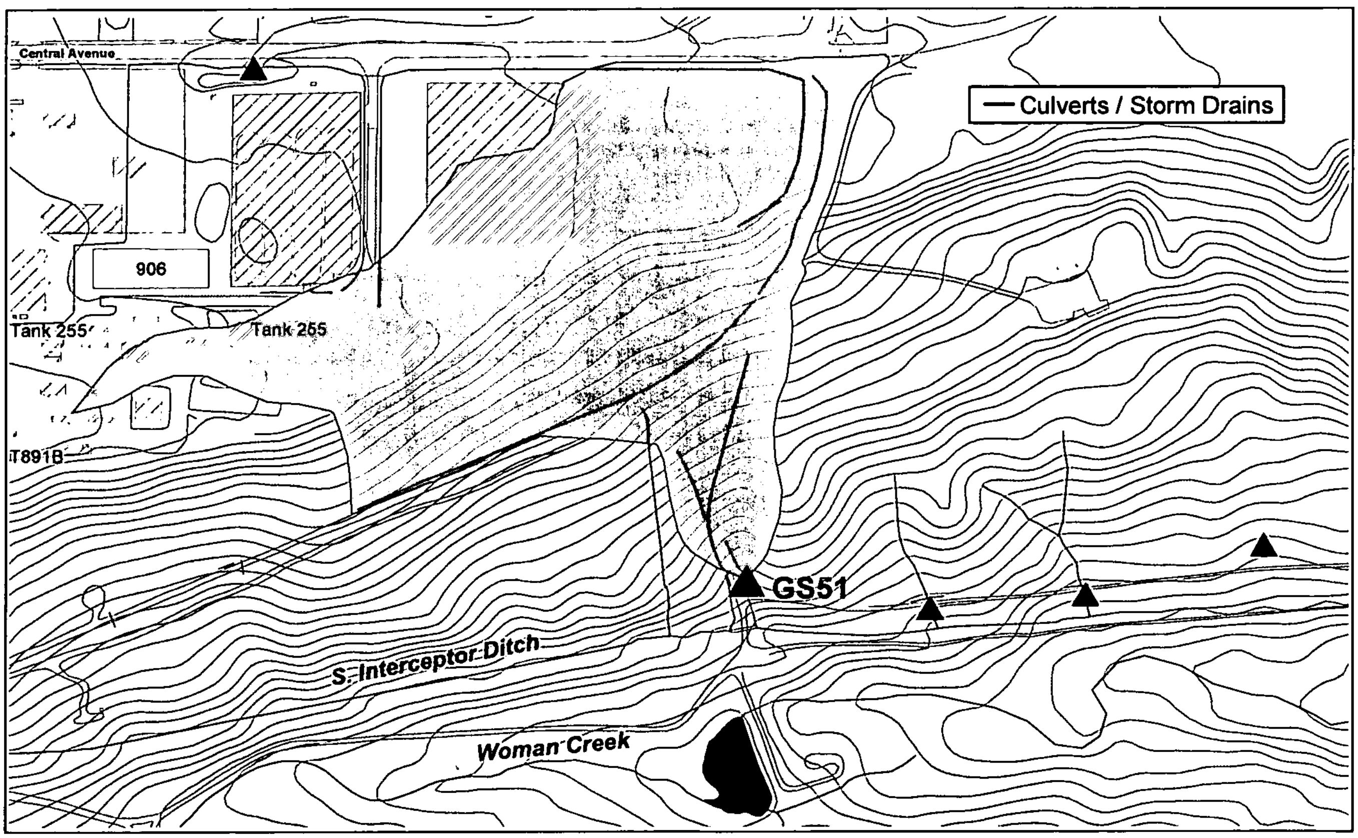


Figure 3-77. Map Showing GS51 Drainage Area.

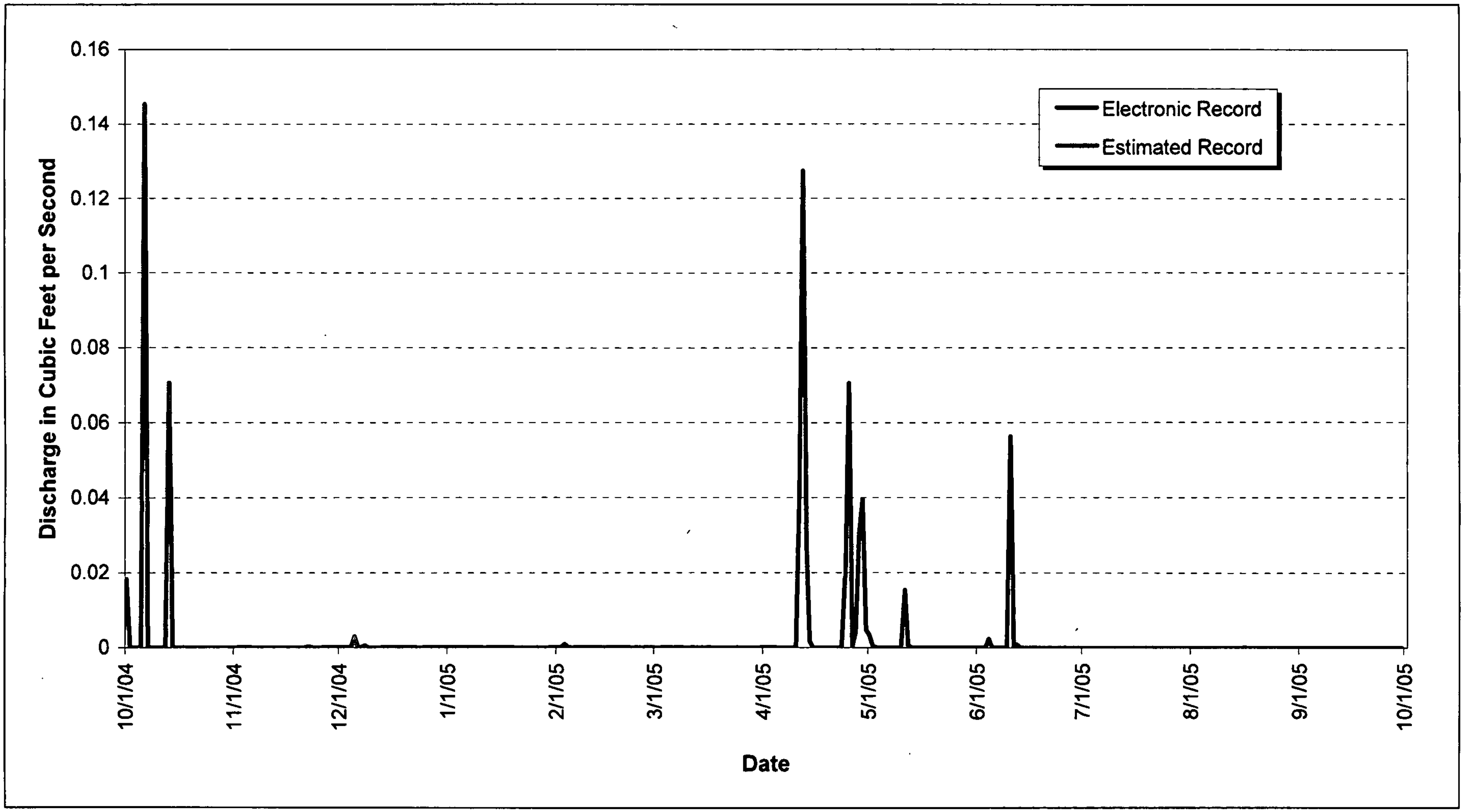


Figure 3-78. WY05 Mean Daily Hydrograph at GS51: Ditch South of 903 Pad.

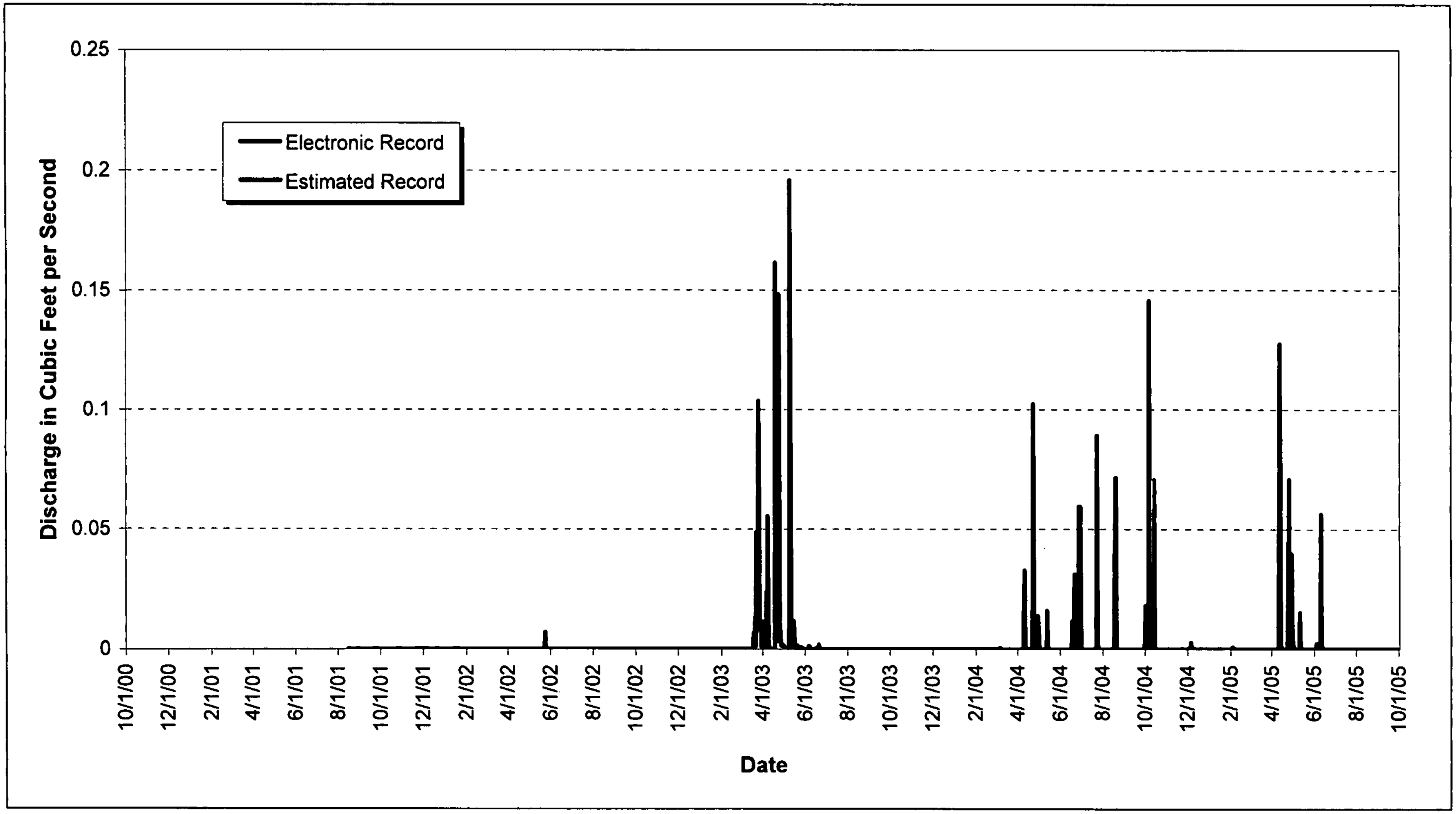


Figure 3-79. WY01-05 Mean Daily Hydrograph at GS51: Ditch South of 903 Pad.

3.2.27 GS52: Drainage Swale Southeast of 903 Pad

Location

Drainage swale southeast of 903 Pad; State Plane: E2086715, N748043

Drainage Area

- The basin includes a swale south and east of the 903 Pad (total of 4.3 acres)
- IA Areas draining to GS52: 900

Period of Record

7/26/01 to 9/7/05 (removed from service)

Gage

Water-stage recorder and 0.6' HS flume

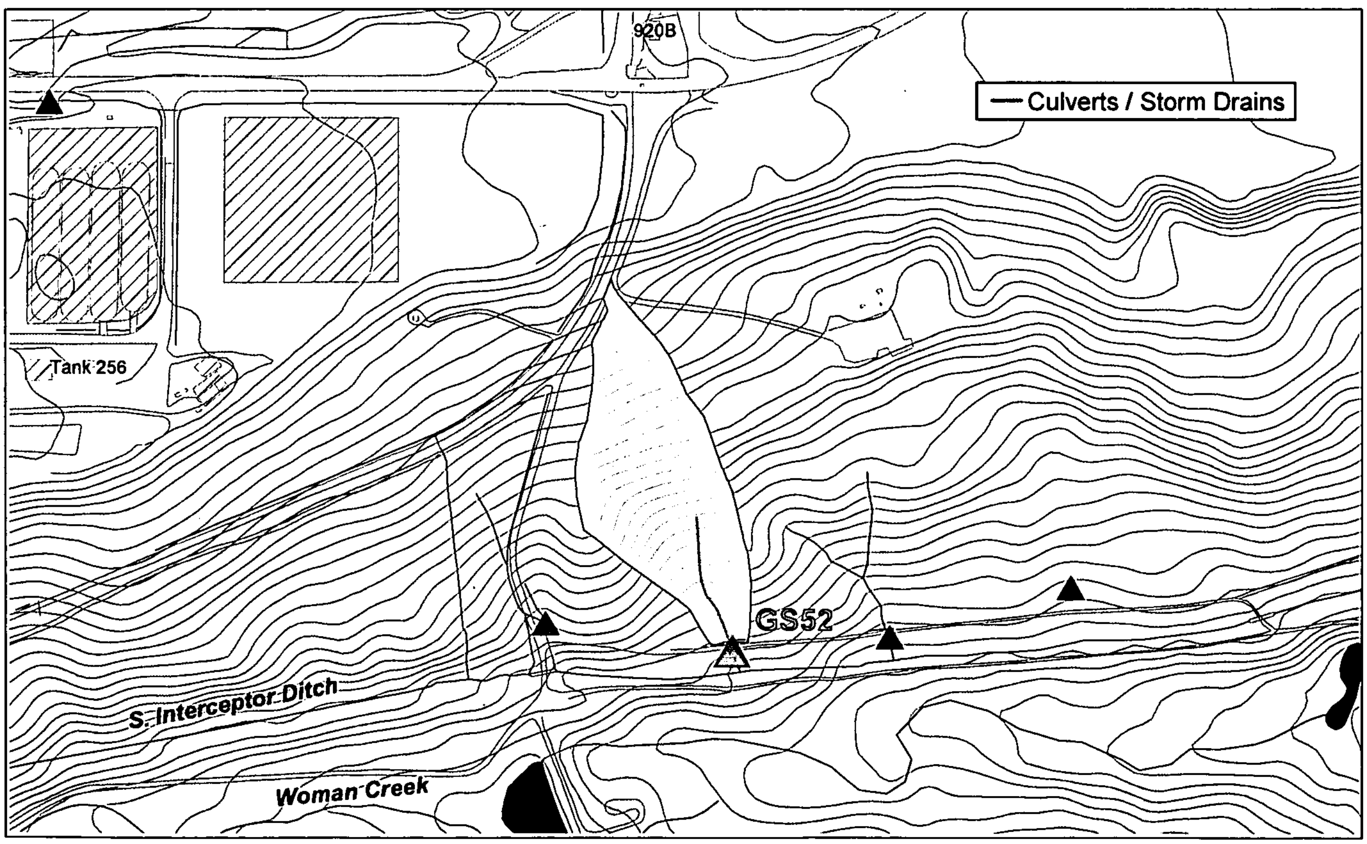


Figure 3-80. Map Showing GS52 Drainage Area.

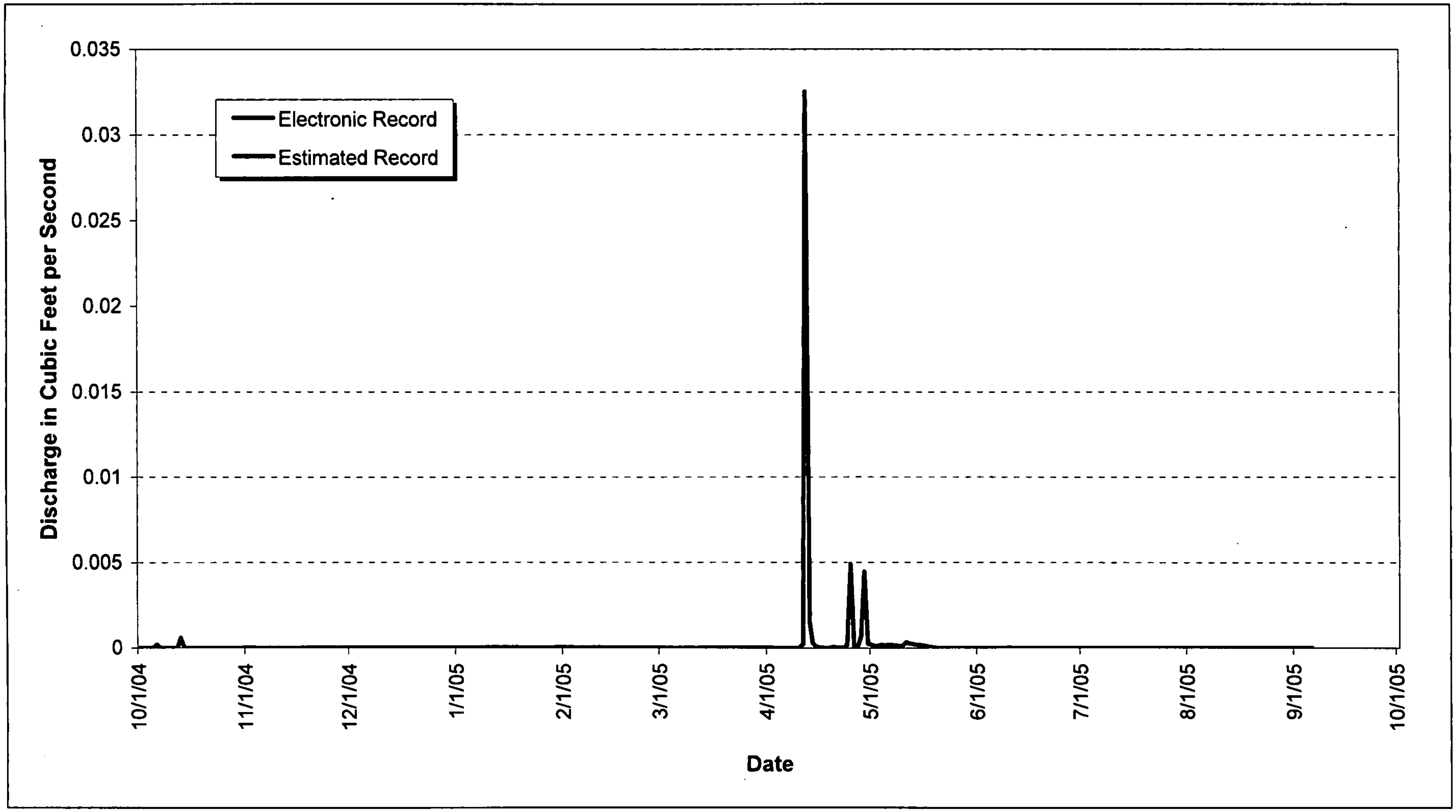


Figure 3-81. WY05 Mean Daily Hydrograph at GS52: Drainage Swale Southeast of 903 Pad.

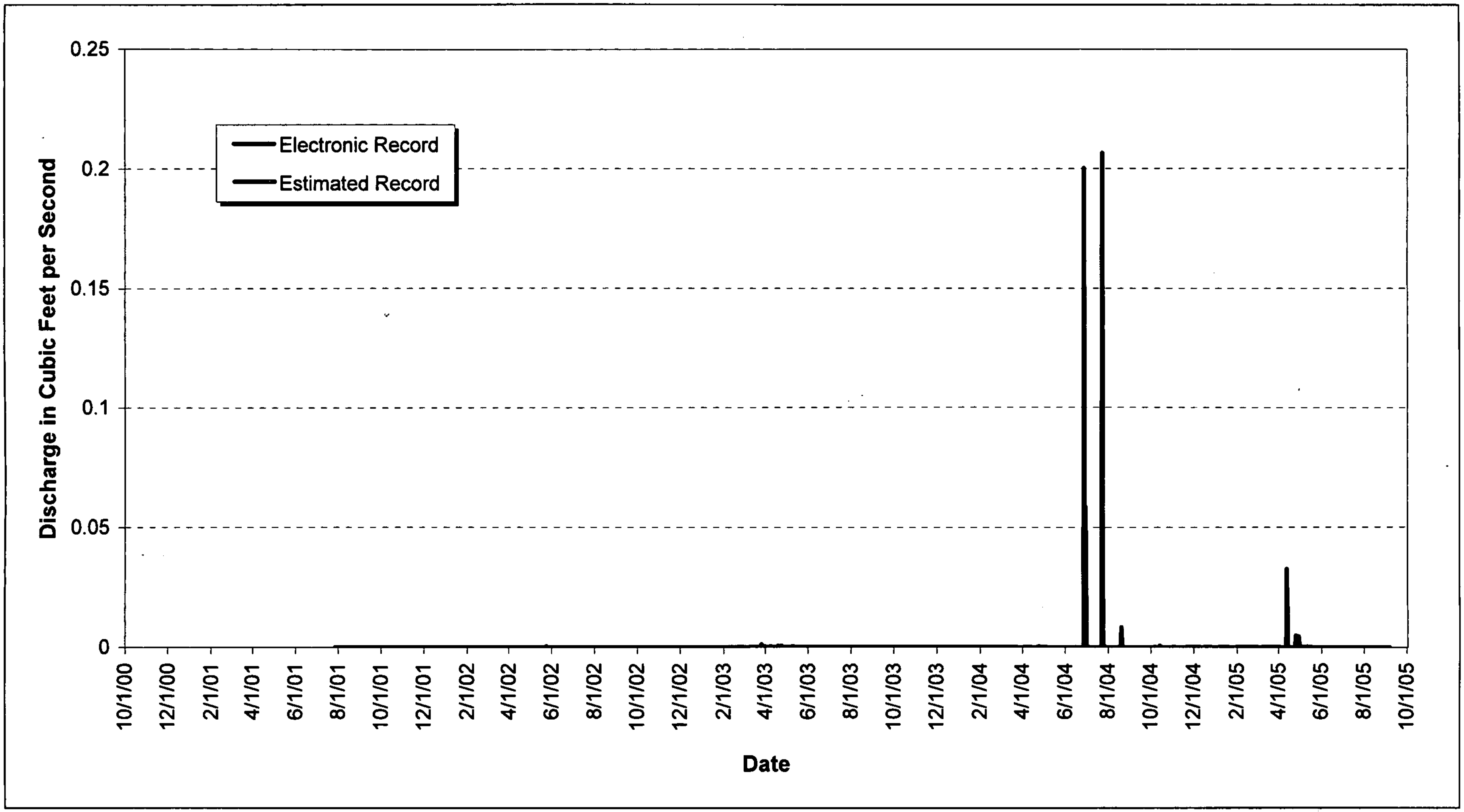


Figure 3-82. WY01-05 Mean Daily Hydrograph at GS52: Drainage Swale Southeast of 903 Pad.

3.2.28 GS53: Drainage Swale Southeast of 903 Pad

Location

Drainage swale southeast of 903 Pad; State Plane: E2087071, N748074

Drainage Area

- The basin includes a swale south and east of the 903 Pad (total of 10.1 acres)
- IA Areas draining to GS53: 900

Period of Record

8/1/01 to 9/7/05 (removed from service)

Gage

Water-stage recorder and 0.6' HS flume

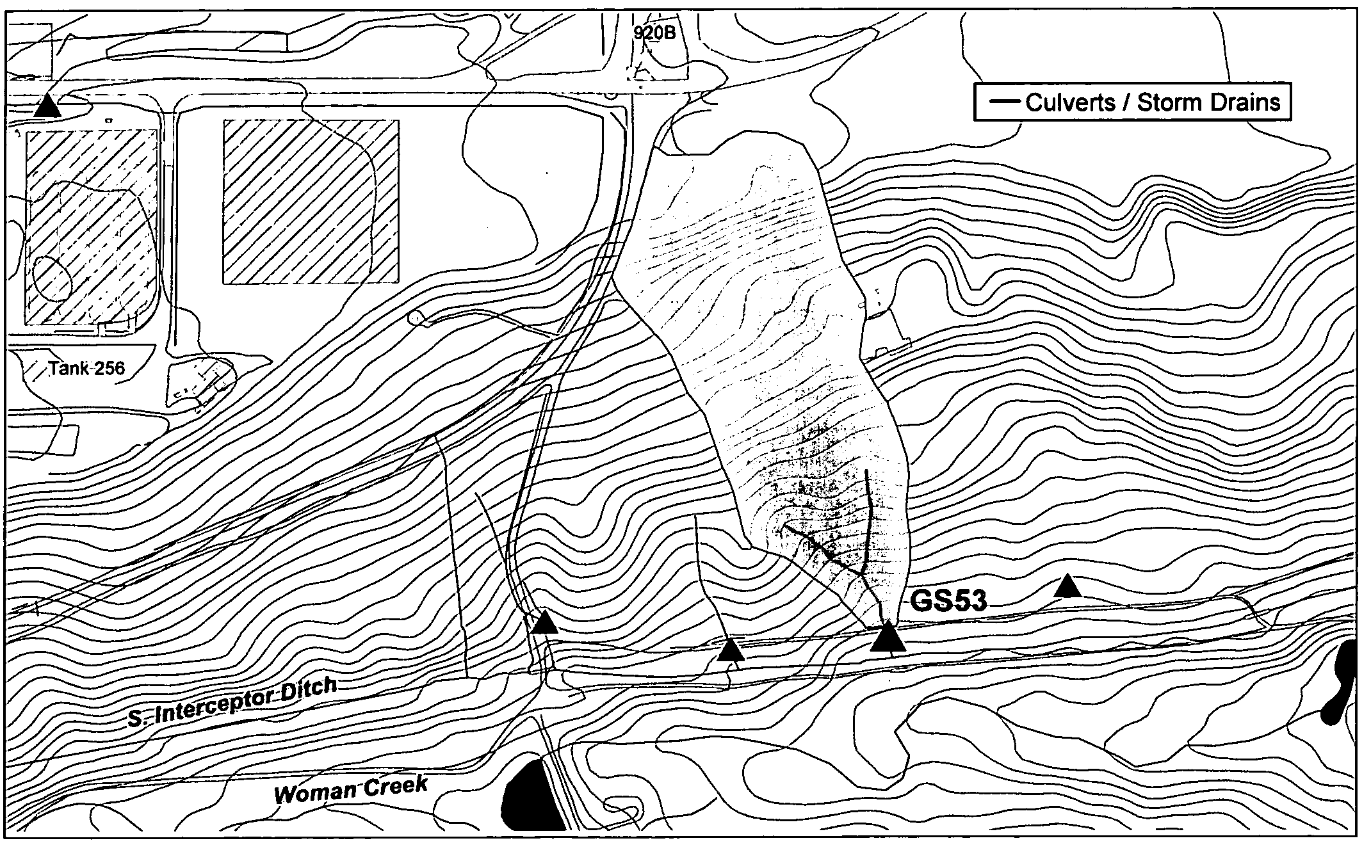


Figure 3-83. Map Showing GS53 Drainage Area.

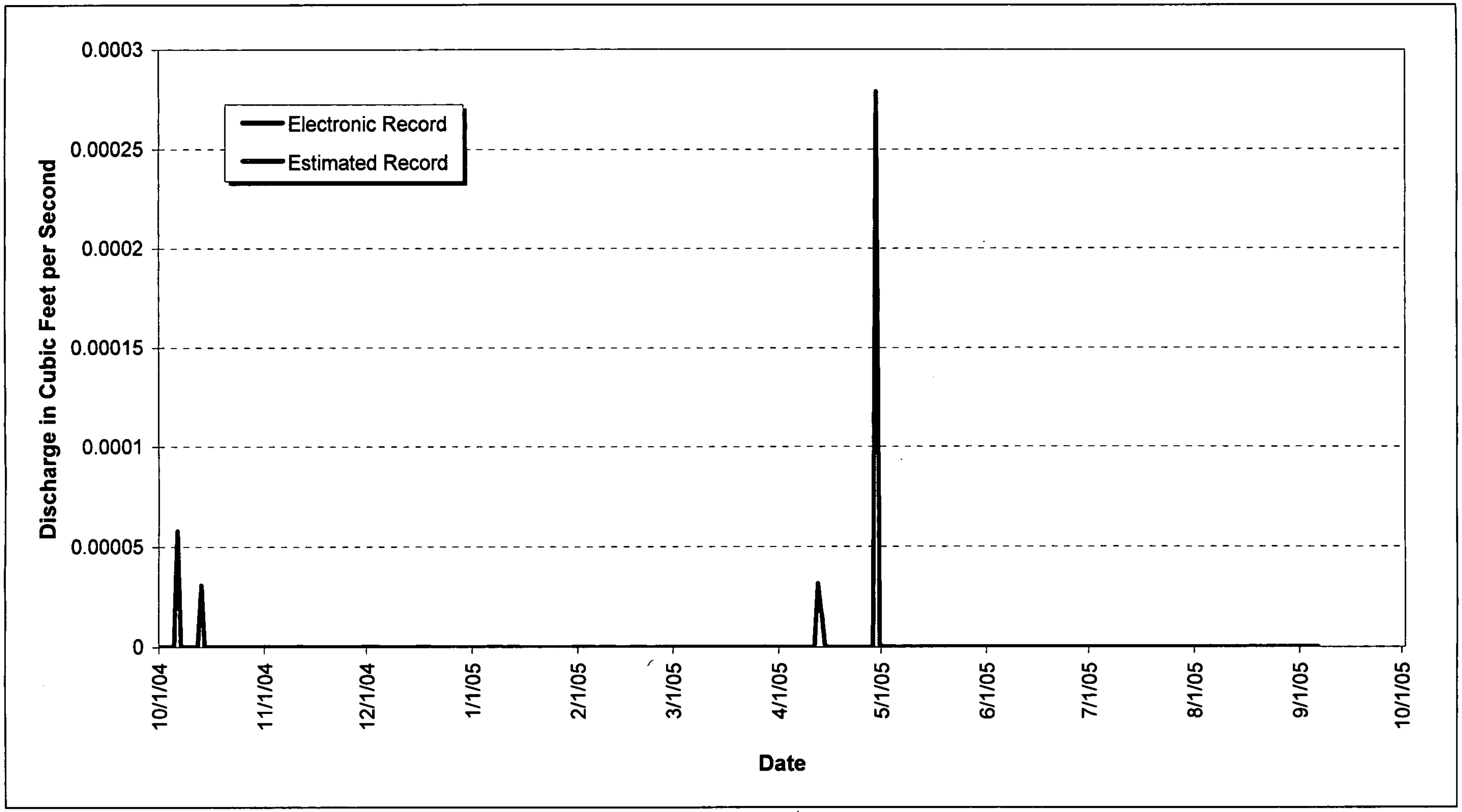


Figure 3-84. WY05 Mean Daily Hydrograph at GS53: Drainage Swale Southeast of 903 Pad.

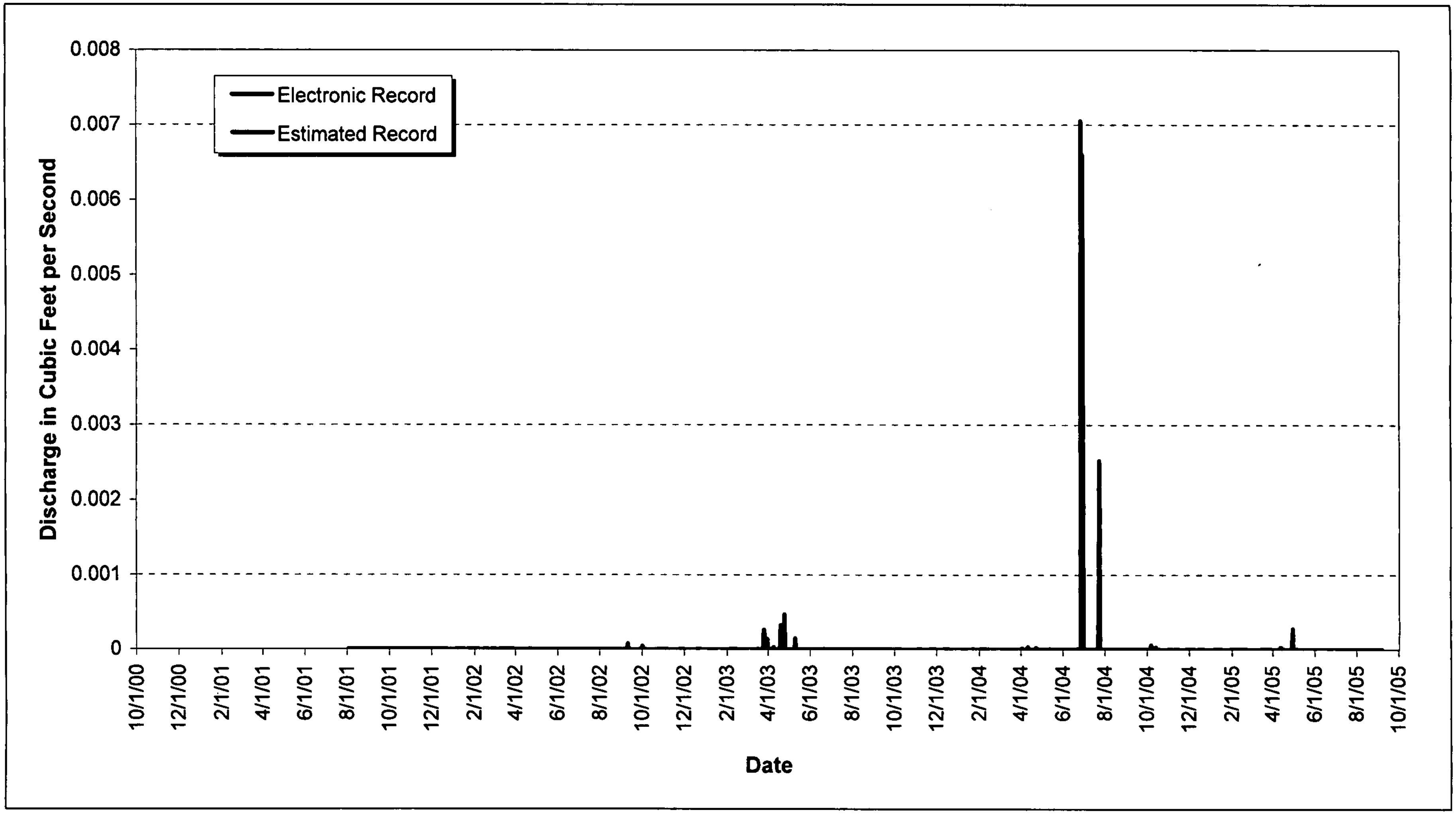


Figure 3-85. WY01-05 Mean Daily Hydrograph at GS53: Drainage Swale Southeast of 903 Pad.

3.2.29 GS54: Drainage Swale East-Southeast of 903 Pad

Location

Drainage swale east-southeast of 903 Pad; State Plane: E2087476, N748188

Drainage Area

- The basin includes a swale south and east of the 903 Pad (total of 9.5 acres)
- IA Areas draining to GS54: 900

Period of Record

8/22/01 to 9/7/05 (removed from service)

Gage

Water-stage recorder and 0.6' HS flume

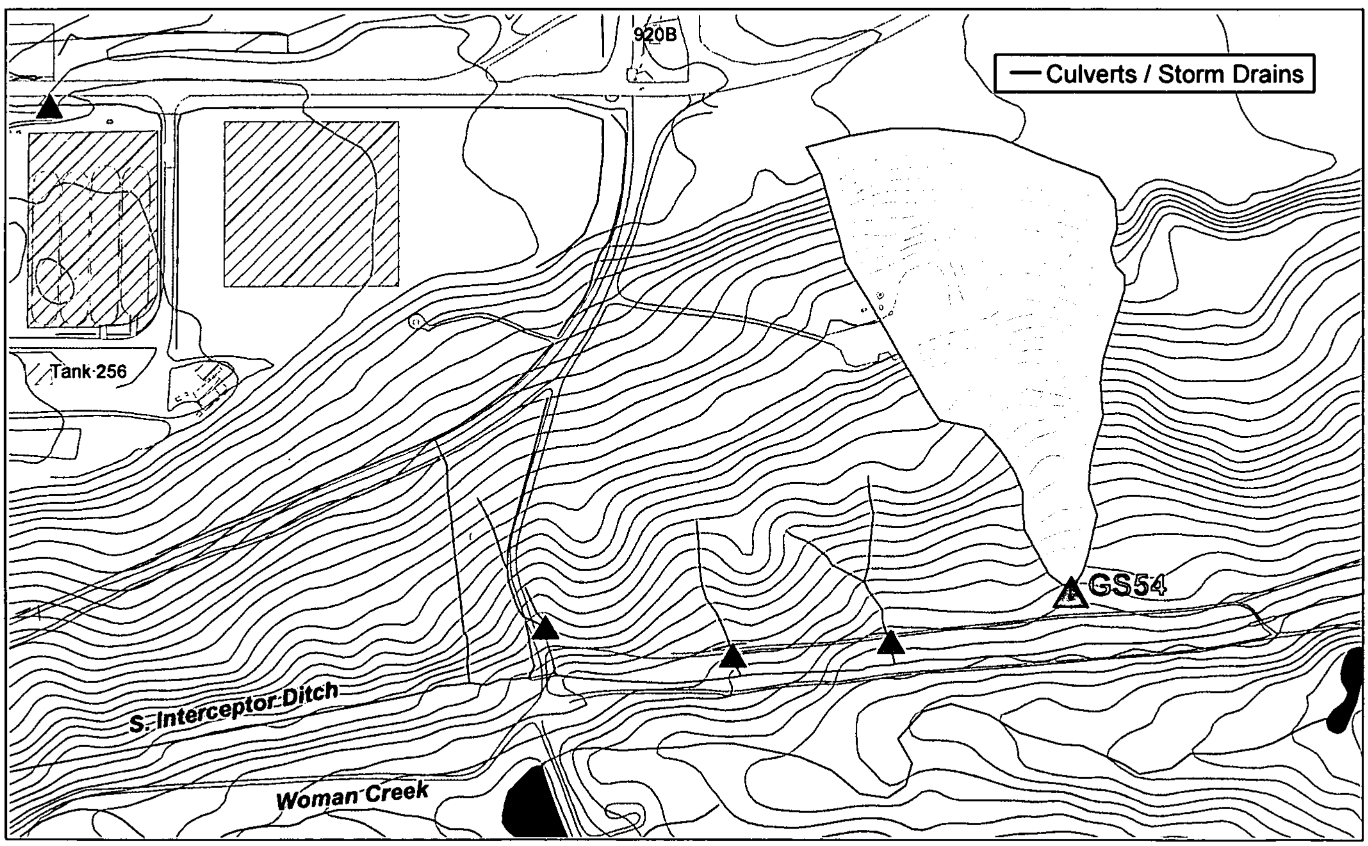


Figure 3-86. Map Showing GS54 Drainage Area.

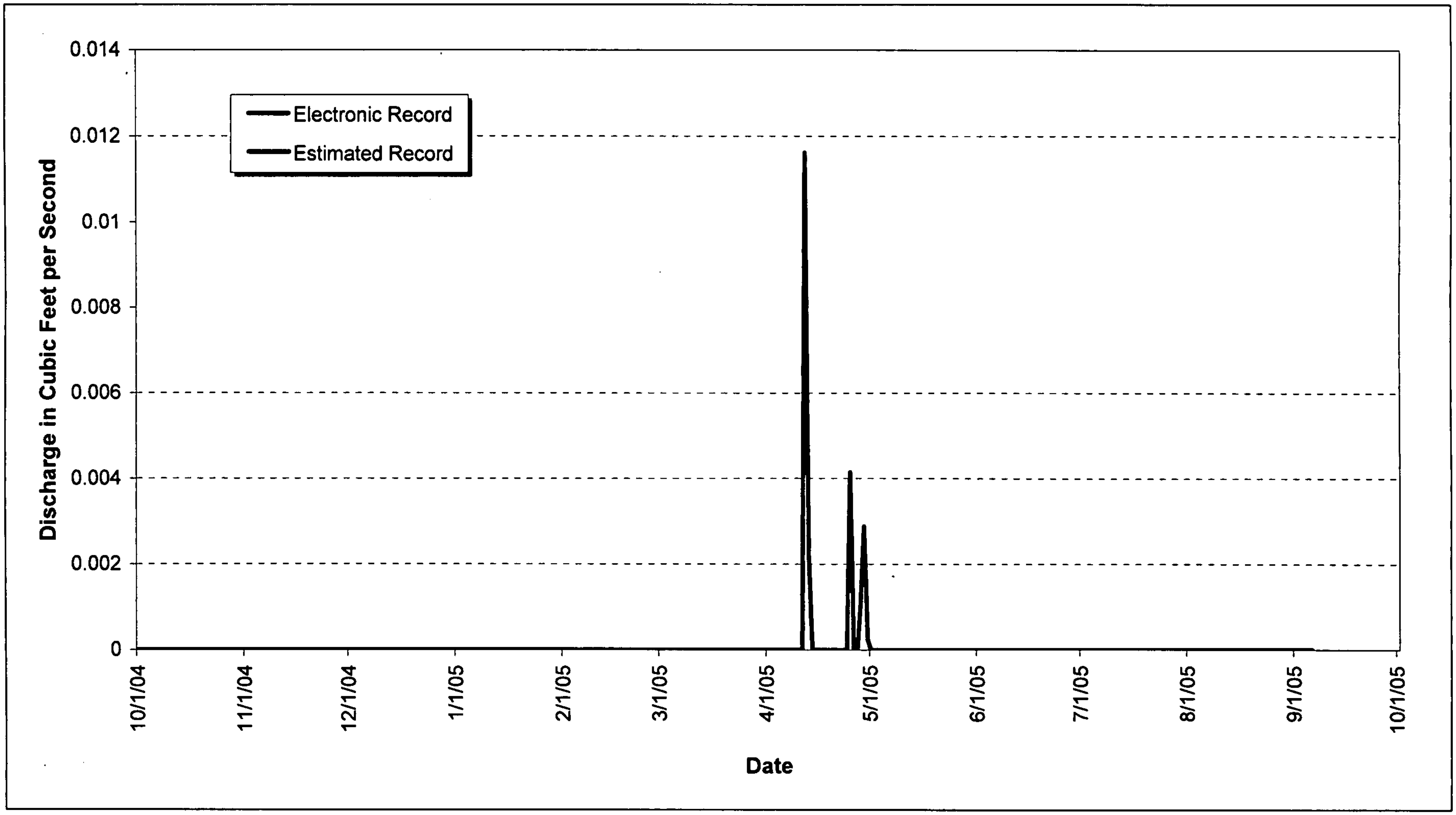


Figure 3-87. WY05 Mean Daily Hydrograph at GS54: Drainage Swale East-Southeast of 903 Pad.

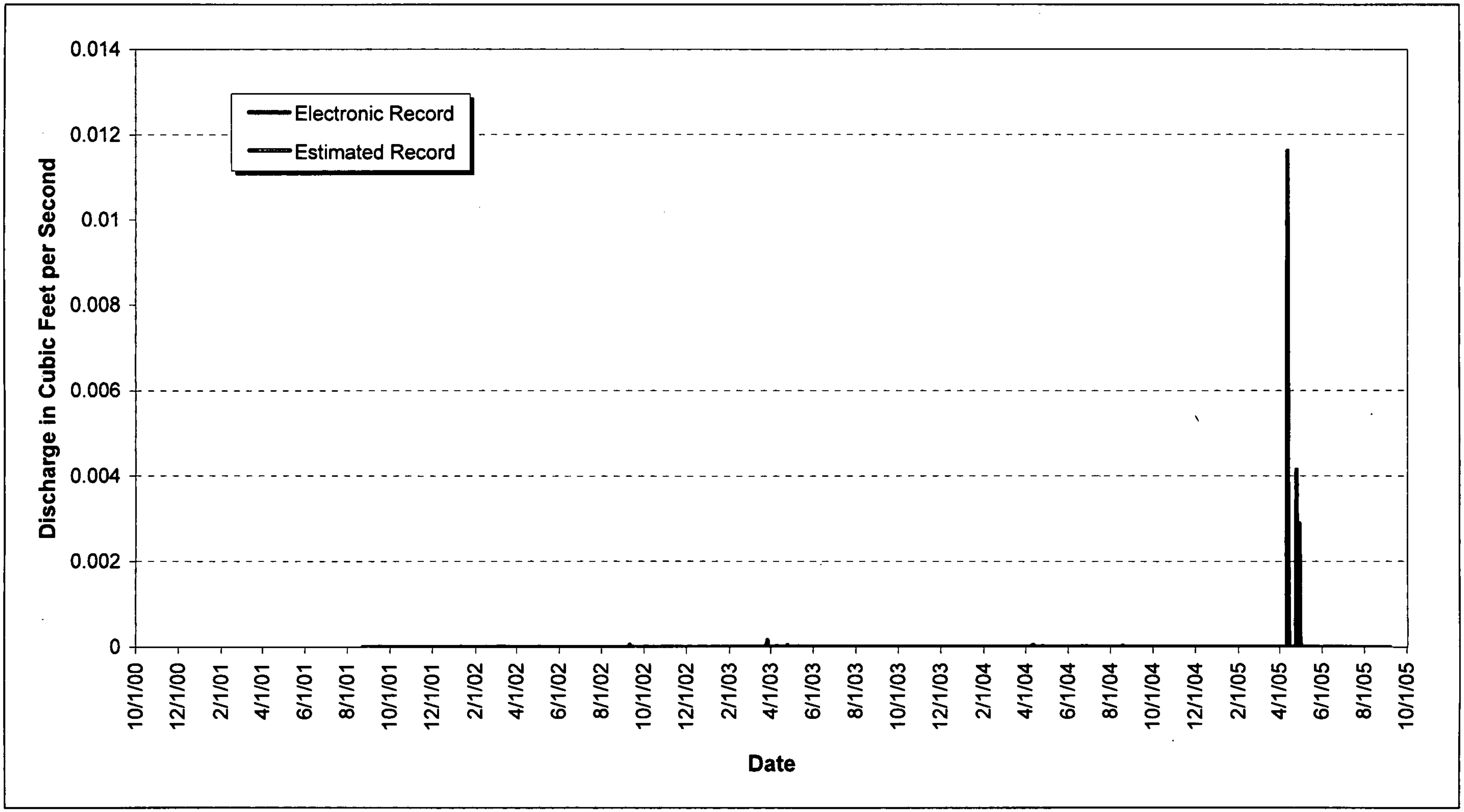


Figure 3-88. WY01-05 Mean Daily Hydrograph at GS54: Drainage Swale East-Southeast of 903 Pad.

3.2.30 GS55: Outfall to SID Draining B881 Area

Location

Outfall of small wetland area south of B881; State Plane: E2084112, N747824

Drainage Area

- The basin includes the entire area surrounding B881 (total of 14.8 acres)
- IA Areas draining to GS55: 800

Period of Record

4/8/02 to 9/12/05 (removed from service)

Gage

Water-stage recorder and 120° V-notch weir box.

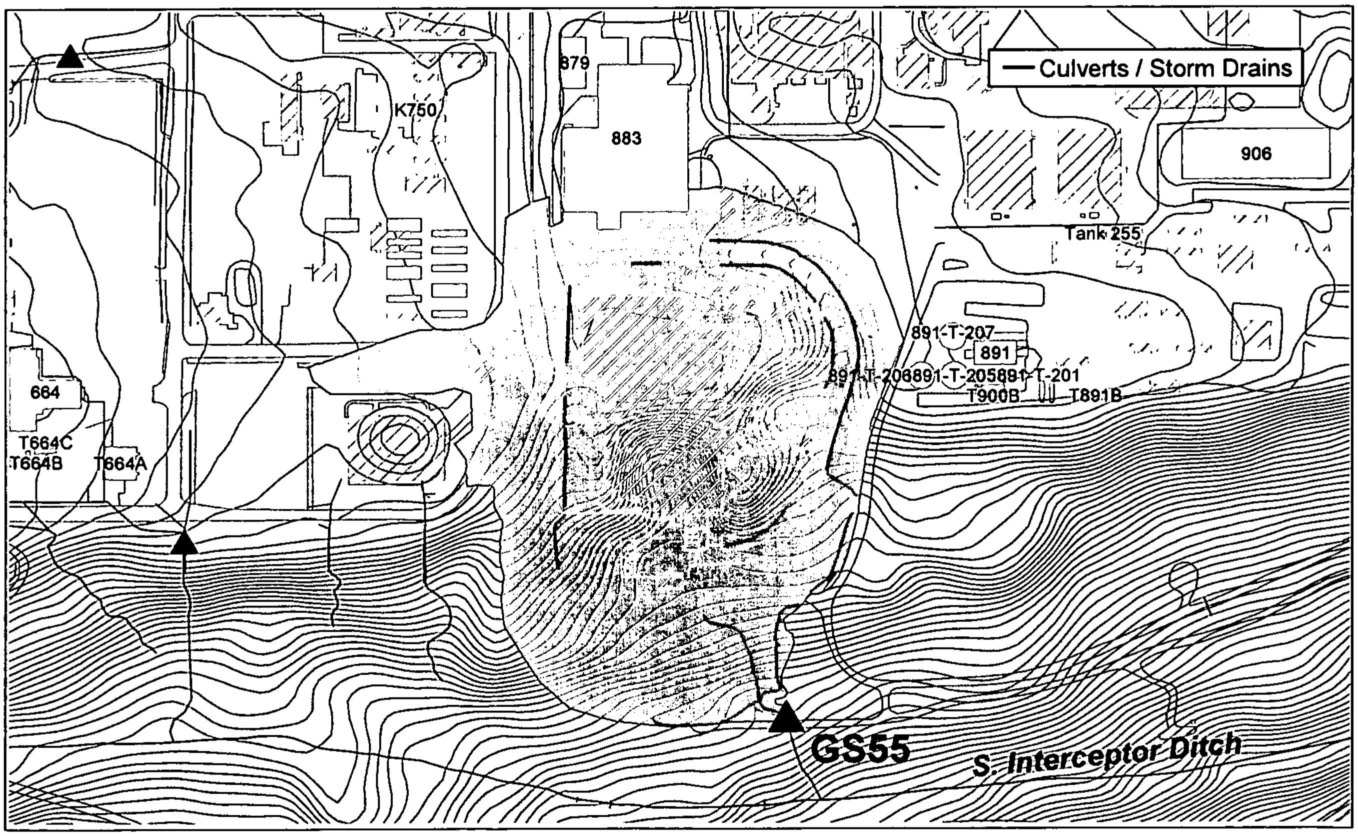


Figure 3-89. Map Showing GS55 Drainage Area.

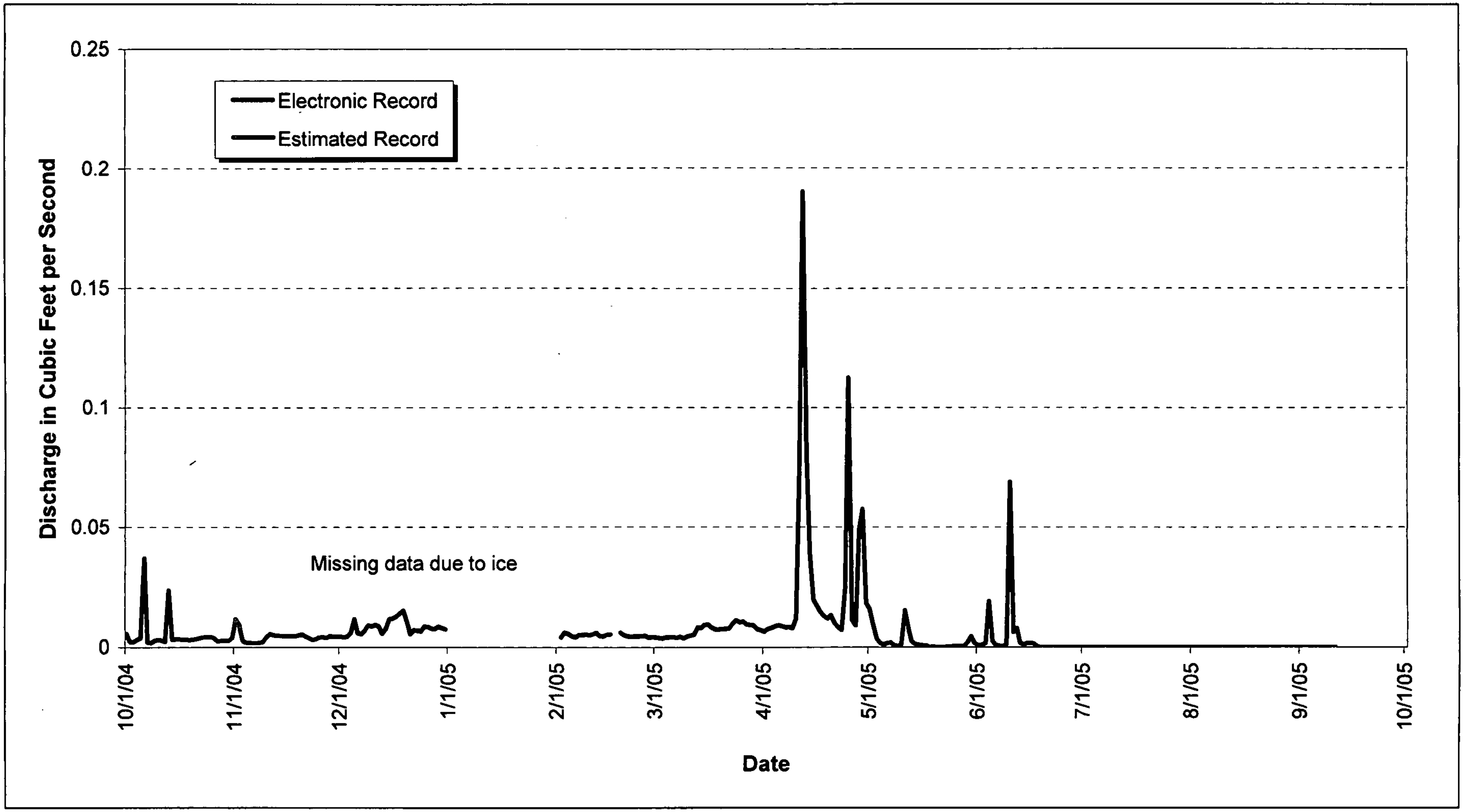


Figure 3-90. WY05 Mean Daily Hydrograph at GS55: Outfall to SID Draining B881 Area.

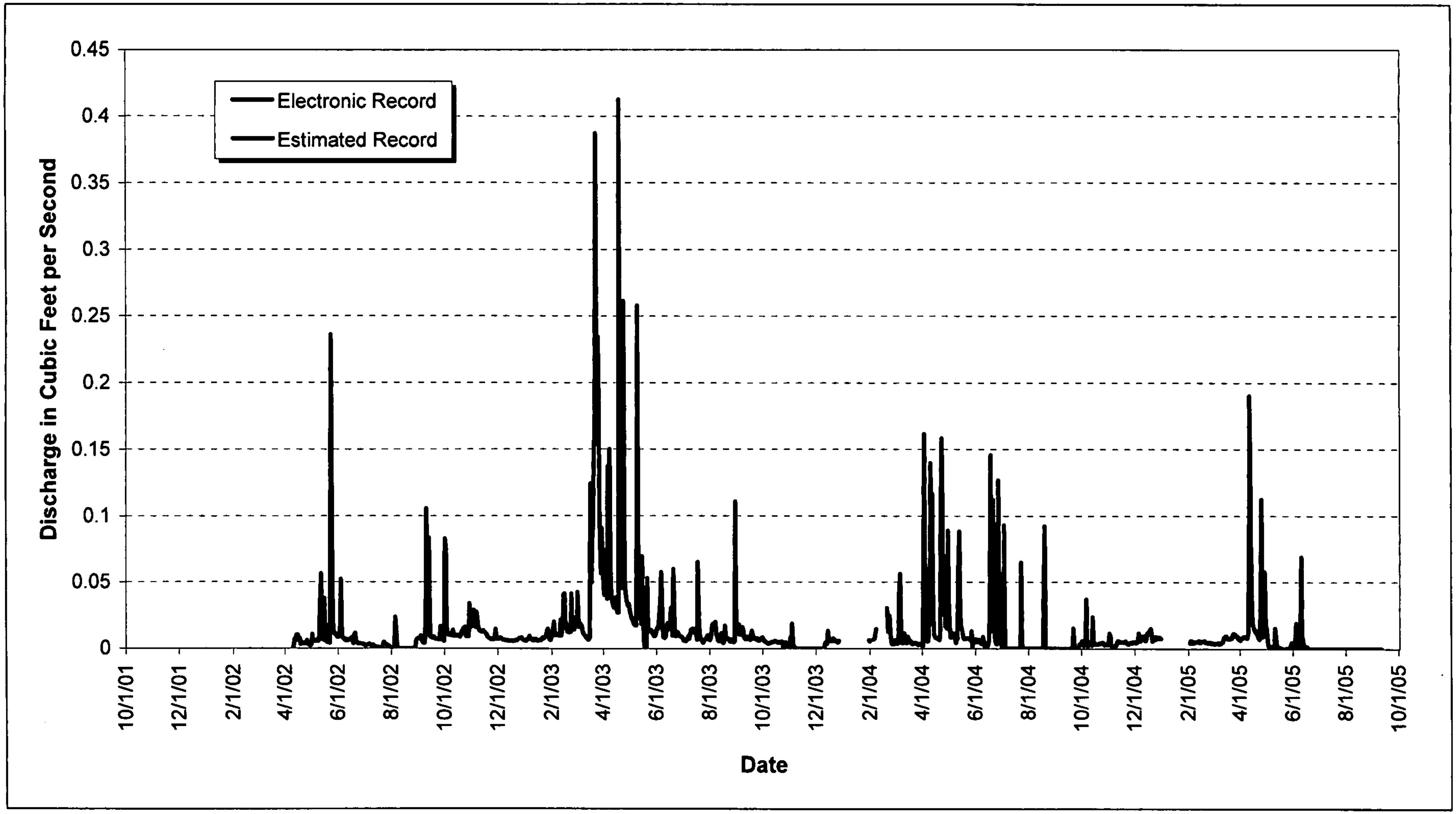


Figure 3-91. WY02-05 Mean Daily Hydrograph at GS55: Outfall to SID Draining B881 Area.

3.2.31 GS56: No Name Gulch 1350 feet Downstream of Landfill Pond

Location

No Name Gulch 1350 ft below Landfill Pond; State Plane: 2085908, 753385

Drainage Area

- The basin includes the entire area surrounding the Present Landfill (total of 106.9 acres); water from the area draining directly to the Landfill Pond is normally pump transferred to the A-Series Ponds
- IA Areas draining to GS56: none

Period of Record

9/26/02 to 9/12/05 (removed from service)

Gage

Water-stage recorder and 9" Parshall flume

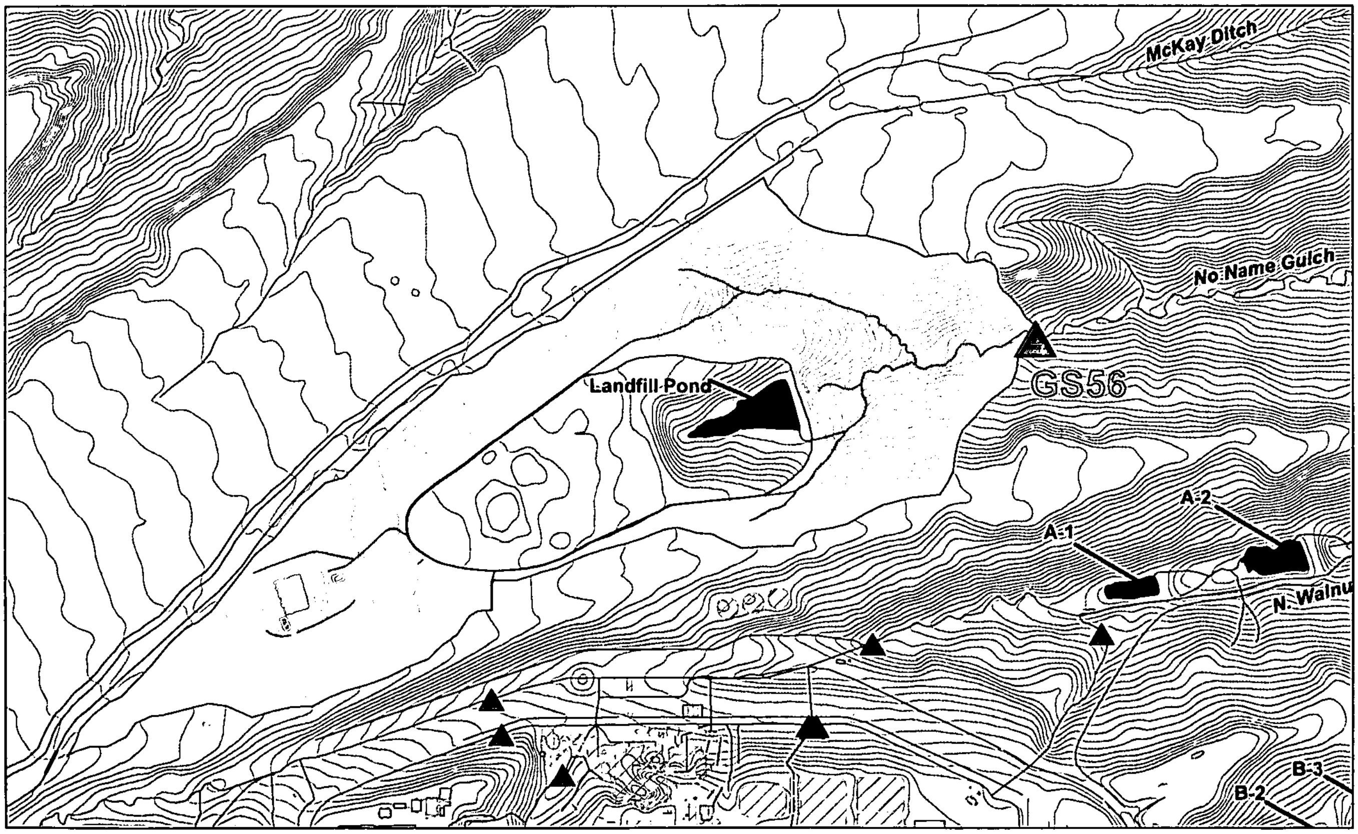


Figure 3-92. Map Showing GS56 Drainage Area.

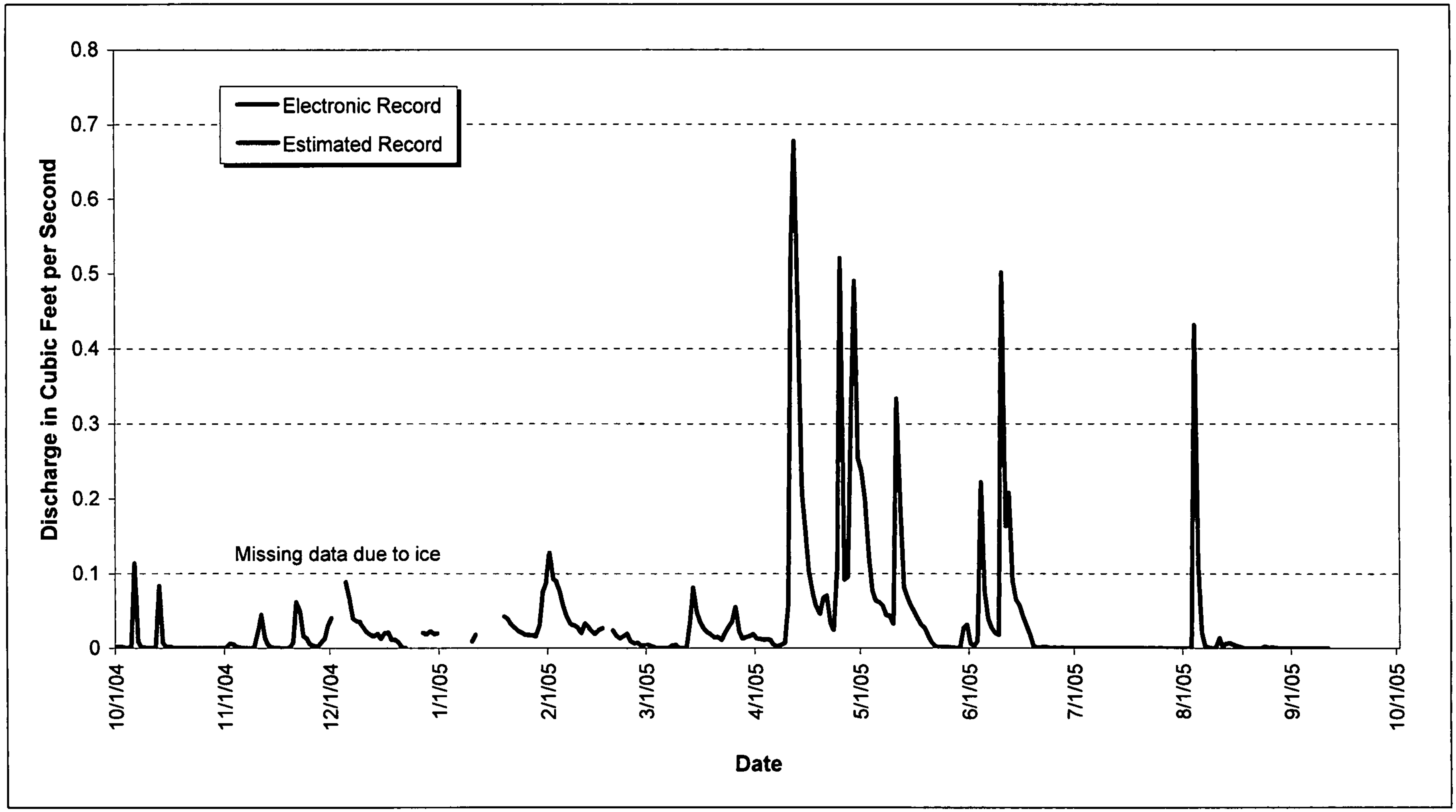


Figure 3-93. WY05 Mean Daily Hydrograph at GS56: No Name Gulch 1350 feet Downstream of Landfill Pond.

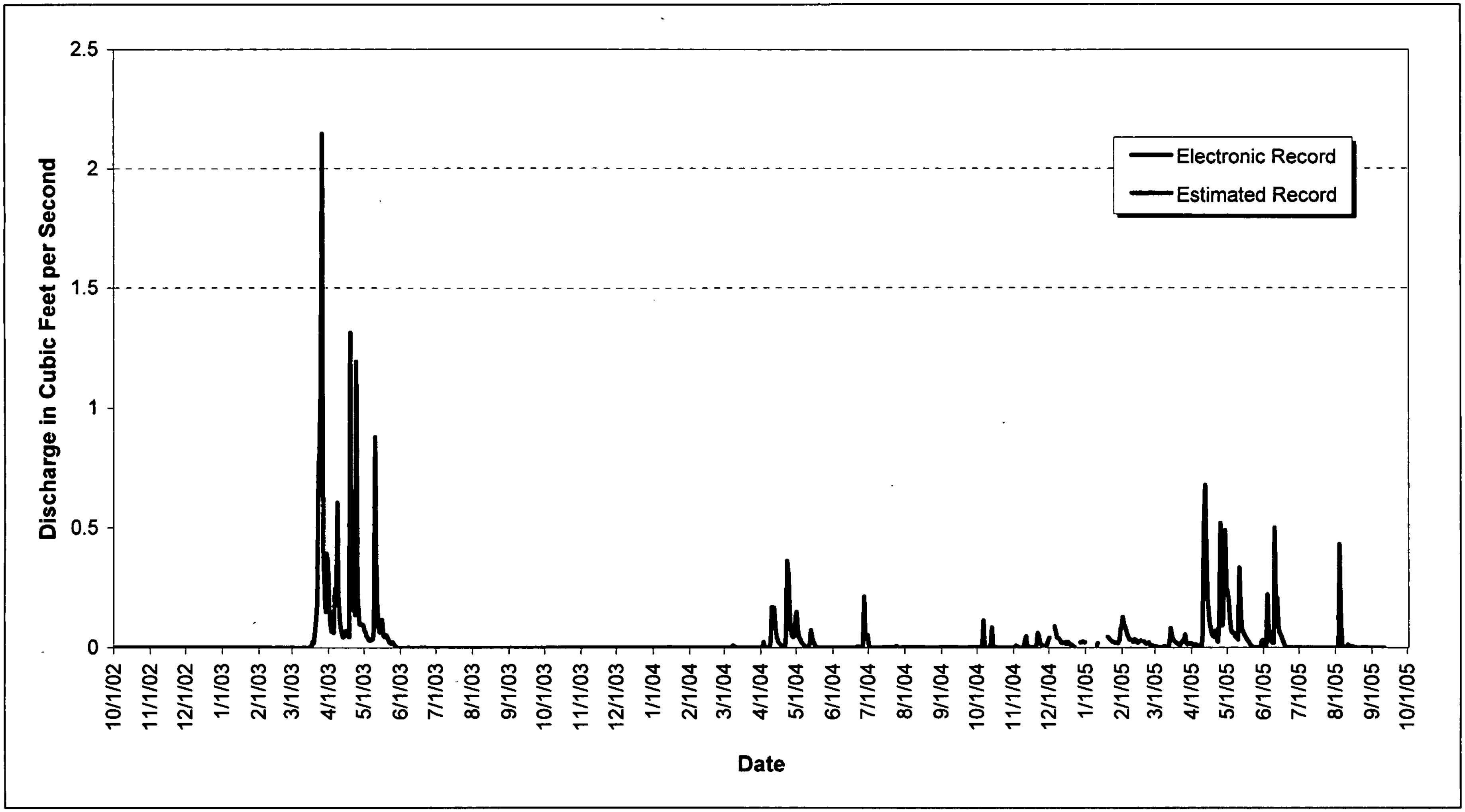


Figure 3-94. WY03-05 Mean Daily Hydrograph at GS56: No Name Gulch 1350 feet Downstream of Landfill Pond.

3.2.32 GS57: Northeast Corner 6th and Cottonwood

Location

Ditch northeast of B444 area; State Plane: E2082847, N749006

Drainage Area

- The basin includes the northeast portion of the 400 Area (total of 8.6 acres)
- IA Areas draining to GS57: 400

Period of Record

3/13/02 to 7/18/05 (removed from service)

Gage

Water-stage recorder and 9.5" Parshall flume

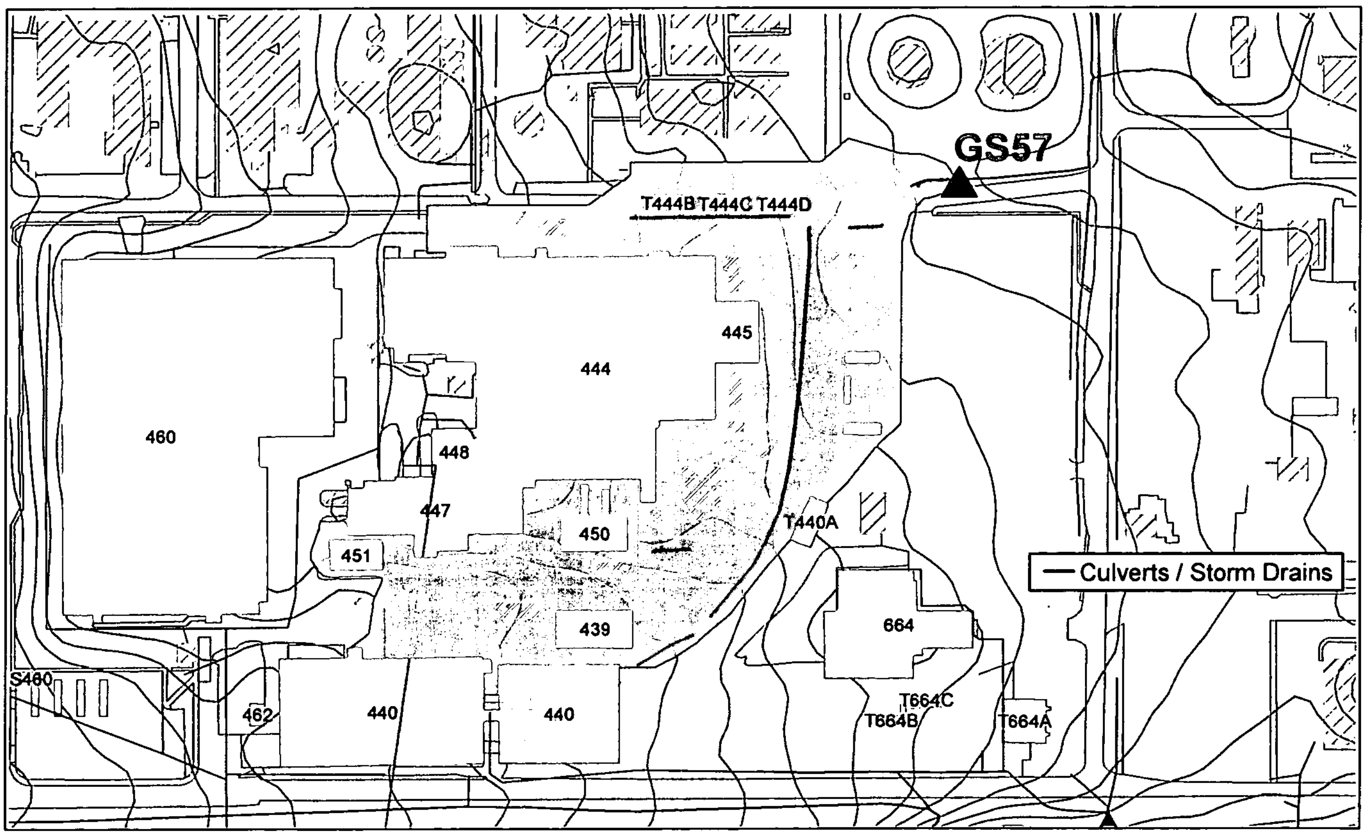


Figure 3-95. Map Showing GS57 Drainage Area.

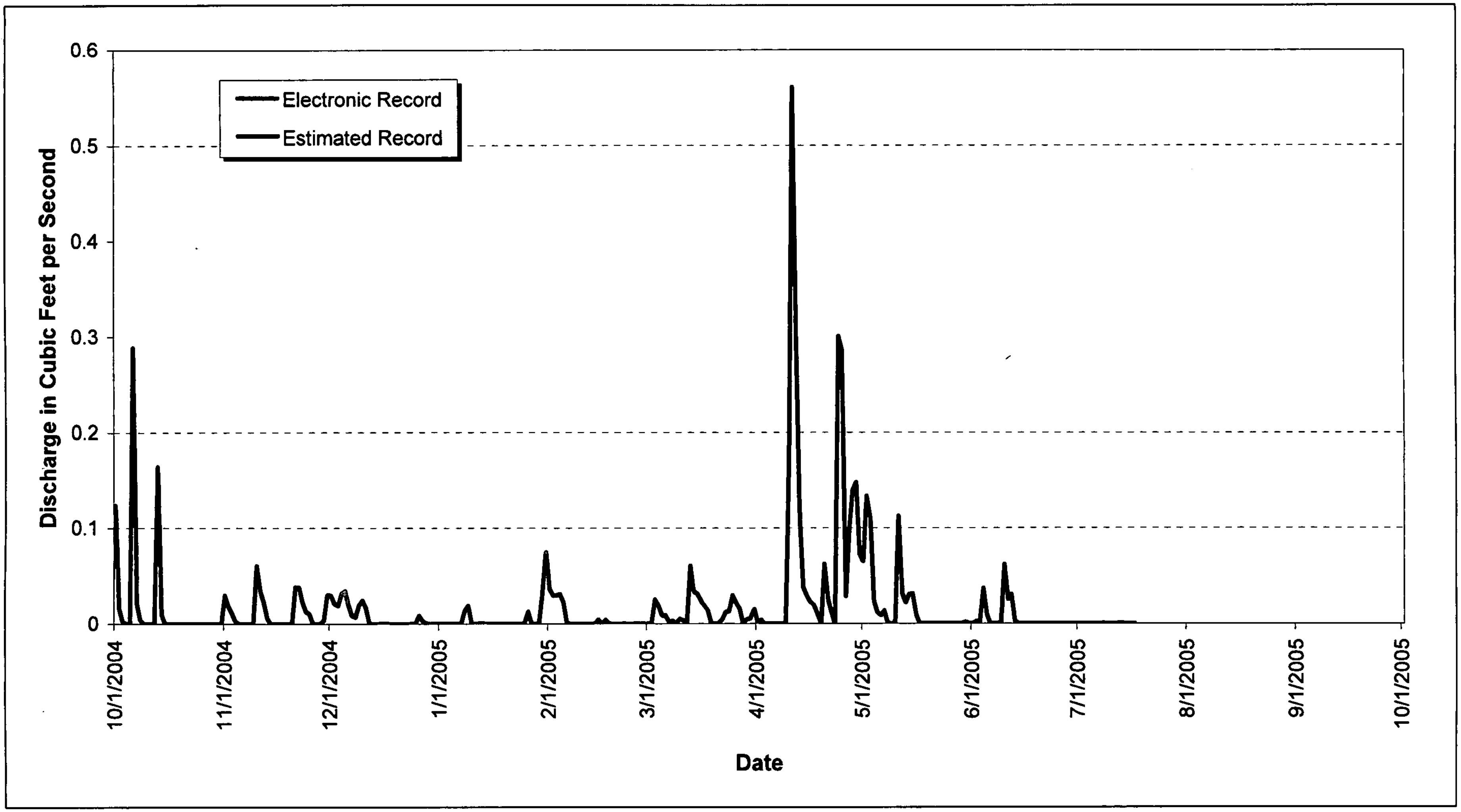


Figure 3-96. WY05 Mean Daily Hydrograph at GS57: Northeast Corner 6th and Cottonwood.

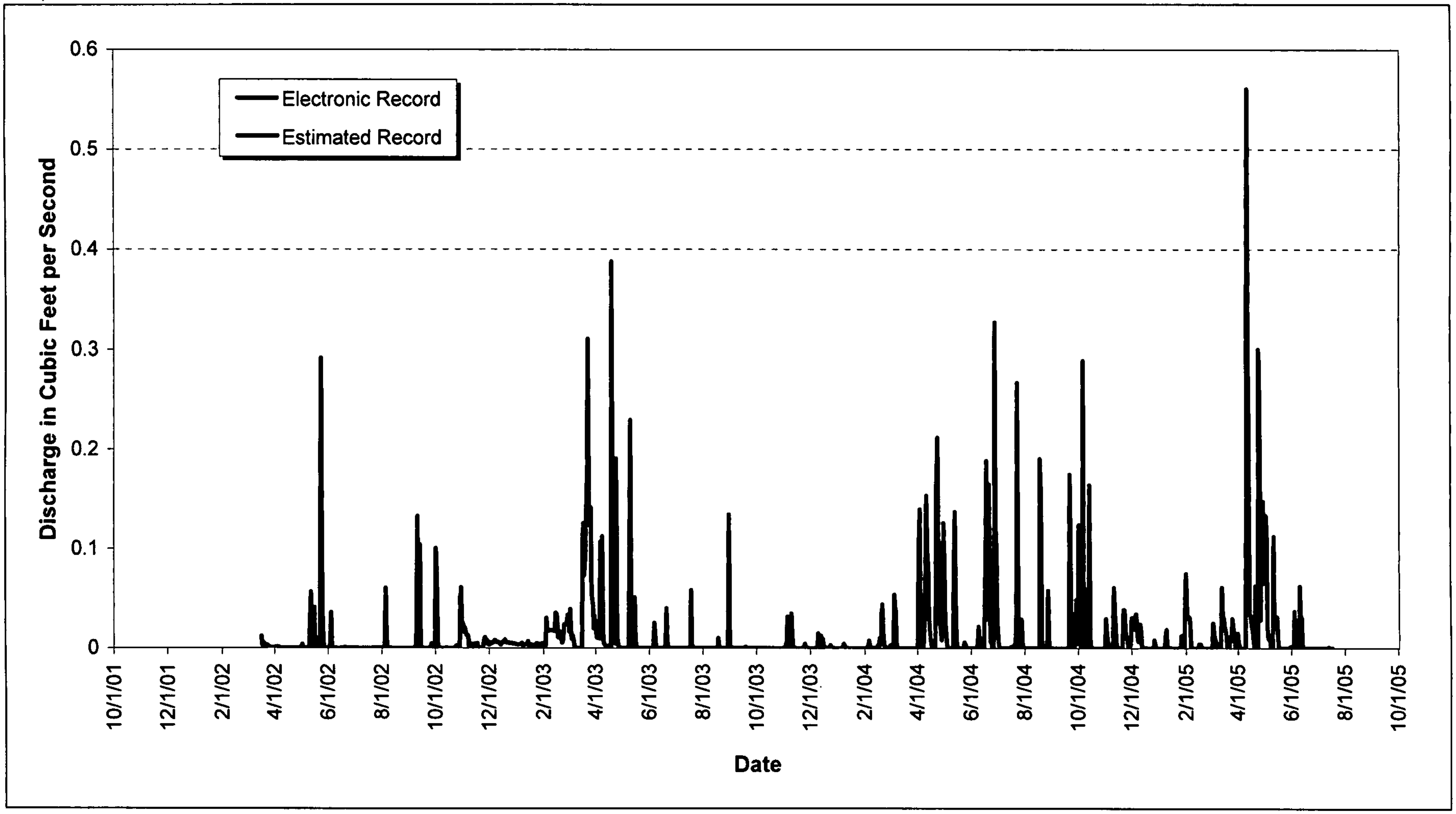


Figure 3-97. WY02-05 Mean Daily Hydrograph at GS57: Northeast Corner 6th and Cottonwood.

3.2.33 GS59: Woman Creek Upstream of Antelope Springs Confluence

Location

Woman Creek 900 ft upstream of Antelope Springs confluence; State Plane: E2083231, N747137

Drainage Area

- The basin includes upstream reaches of the Woman Creek; areas west of Highway 93 also contribute runoff (total drainage acreage undetermined)
- IA Areas draining to GS59: None

Period of Record

11/20/02 to current year

Gage

Water-stage recorder and 1.5' Parshall flume

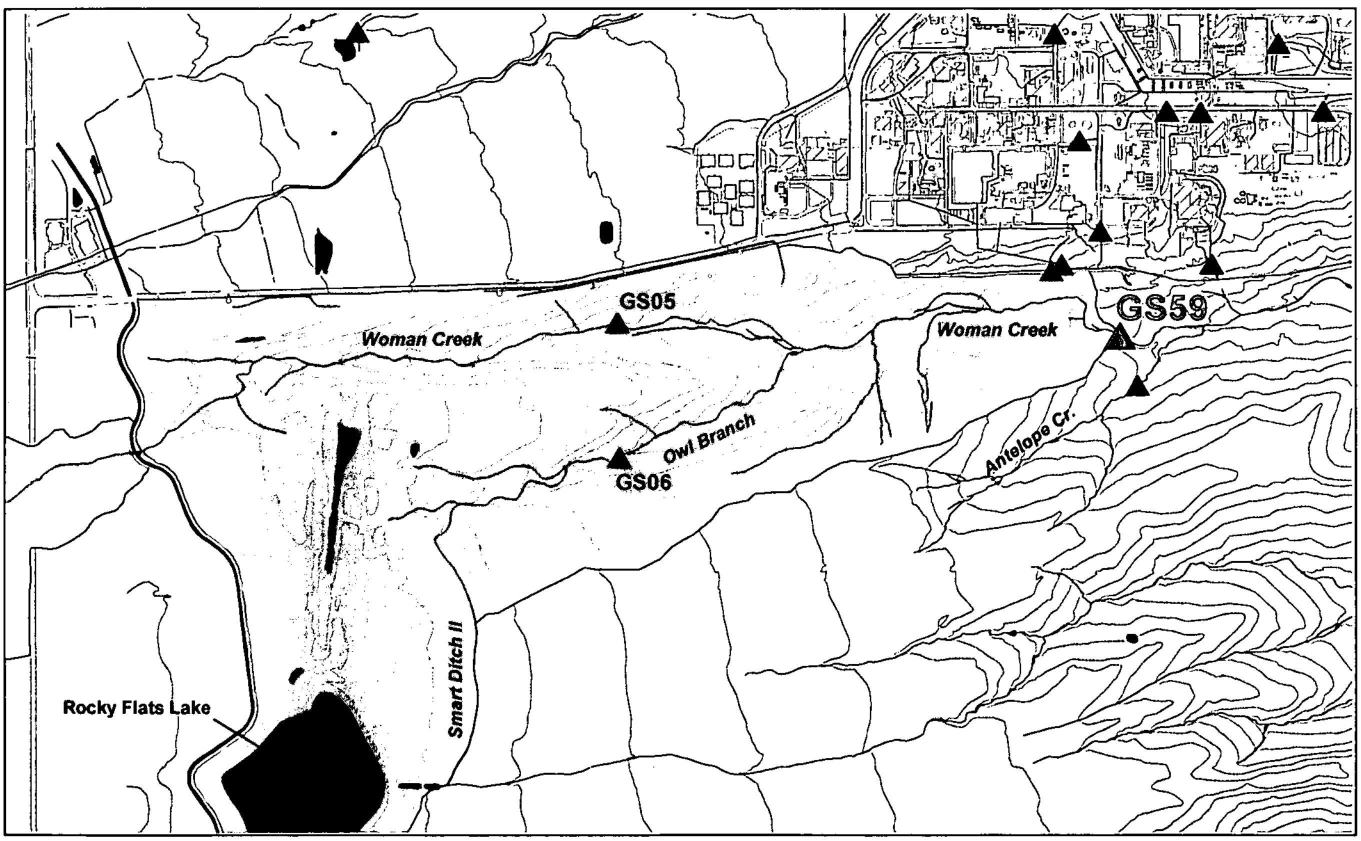


Figure 3-98. Map Showing GS59 Drainage Area.

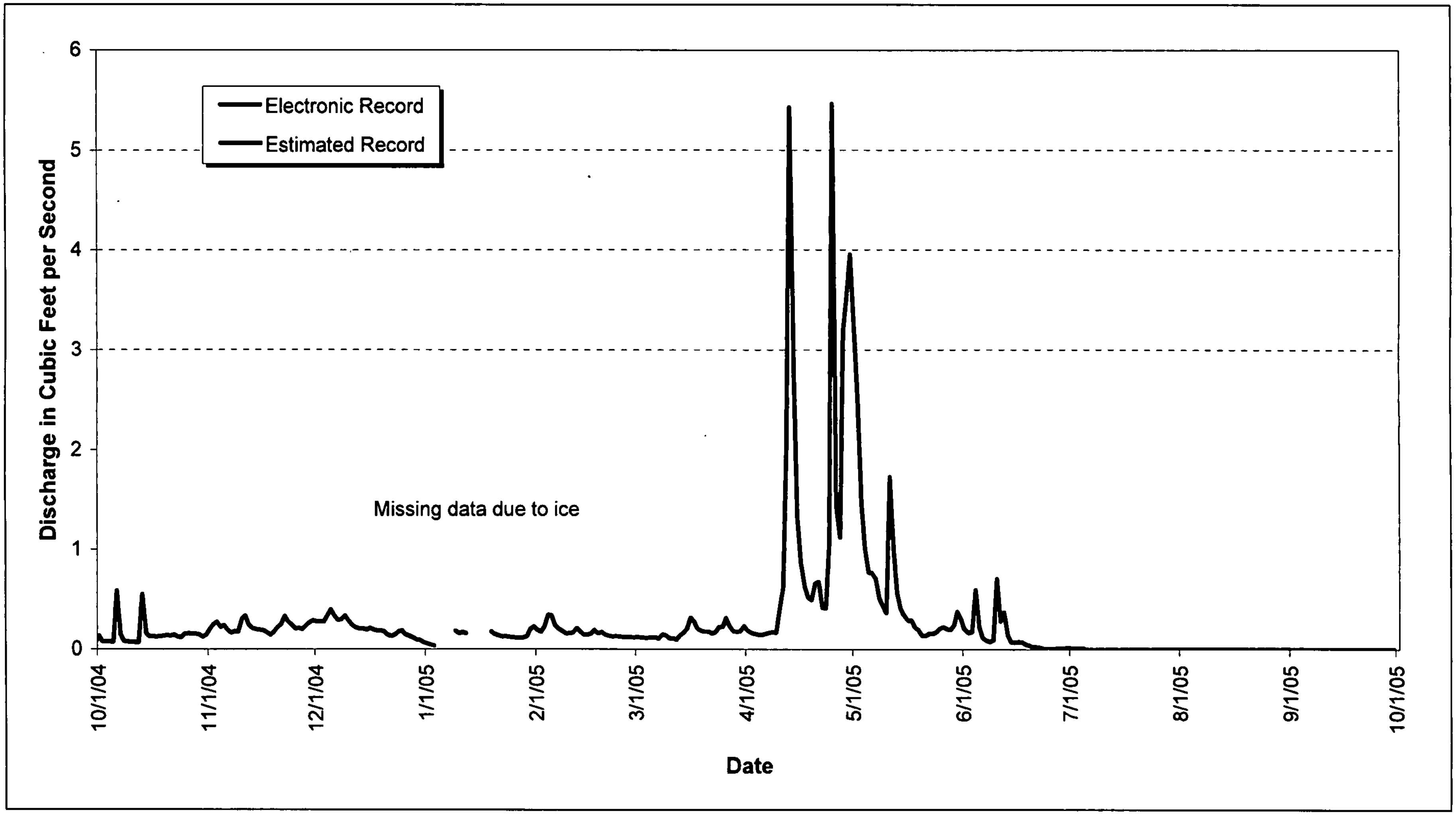


Figure 3-99. WY05 Mean Daily Hydrograph at GS59: Woman Creek Upstream of Antelope Springs Confluence.

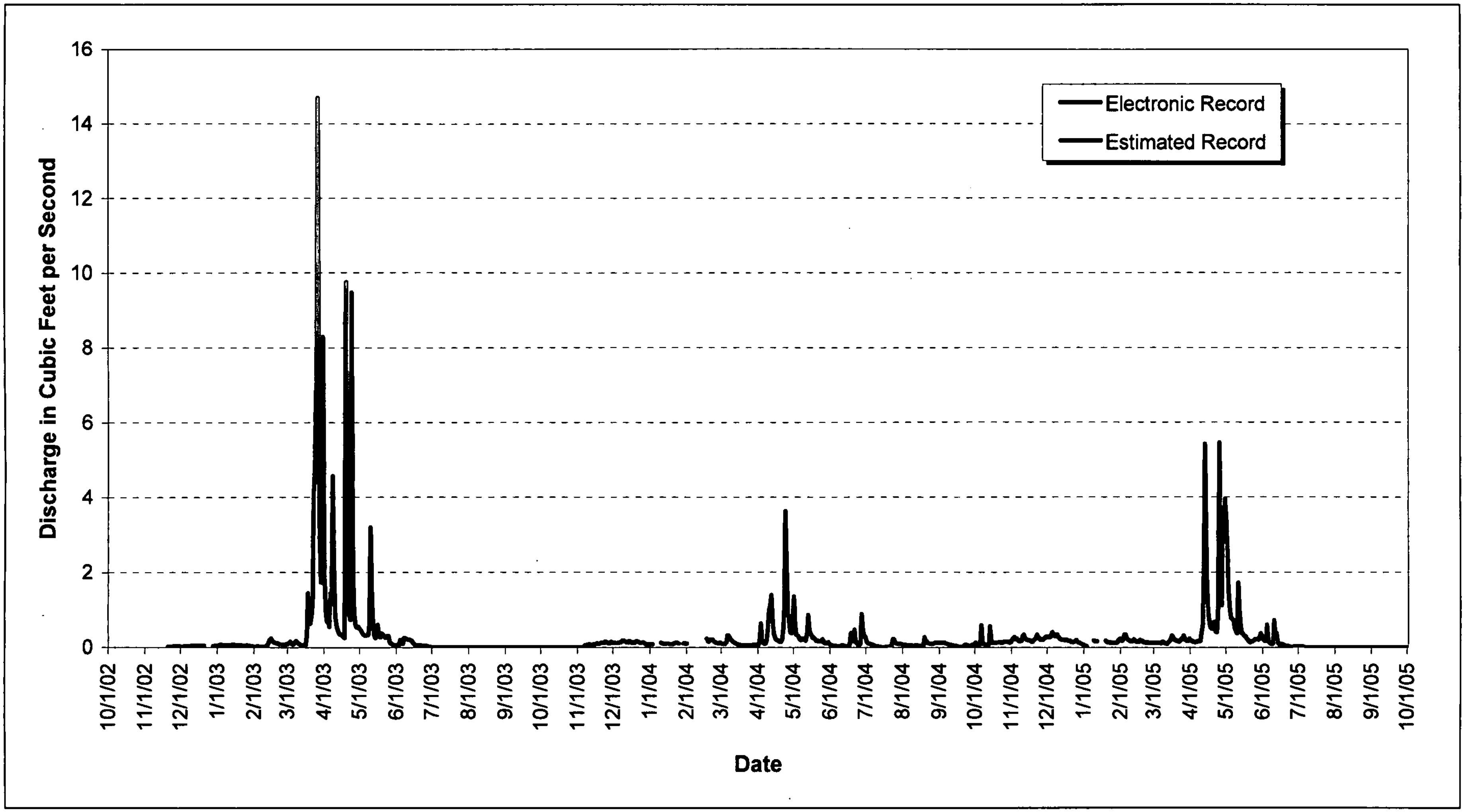


Figure 3-100. WY03-05 Mean Daily Hydrograph at GS59: Woman Creek Upstream of Antelope Springs Confluence.

3.2.34 GS60: Northern B371 Subdrainage Area

Location

Ditch northeast of B371 along former PA perimeter road; State Plane: E2083015, N751226

Drainage Area

- The basin includes areas on the west and north of B371/374 (total of 9.7 acres)
- IA Areas draining to GS60: 300

Period of Record

8/13/03 to 7/21/05 (removed from service)

Gage

Water-stage recorder and 6' Parshall flume

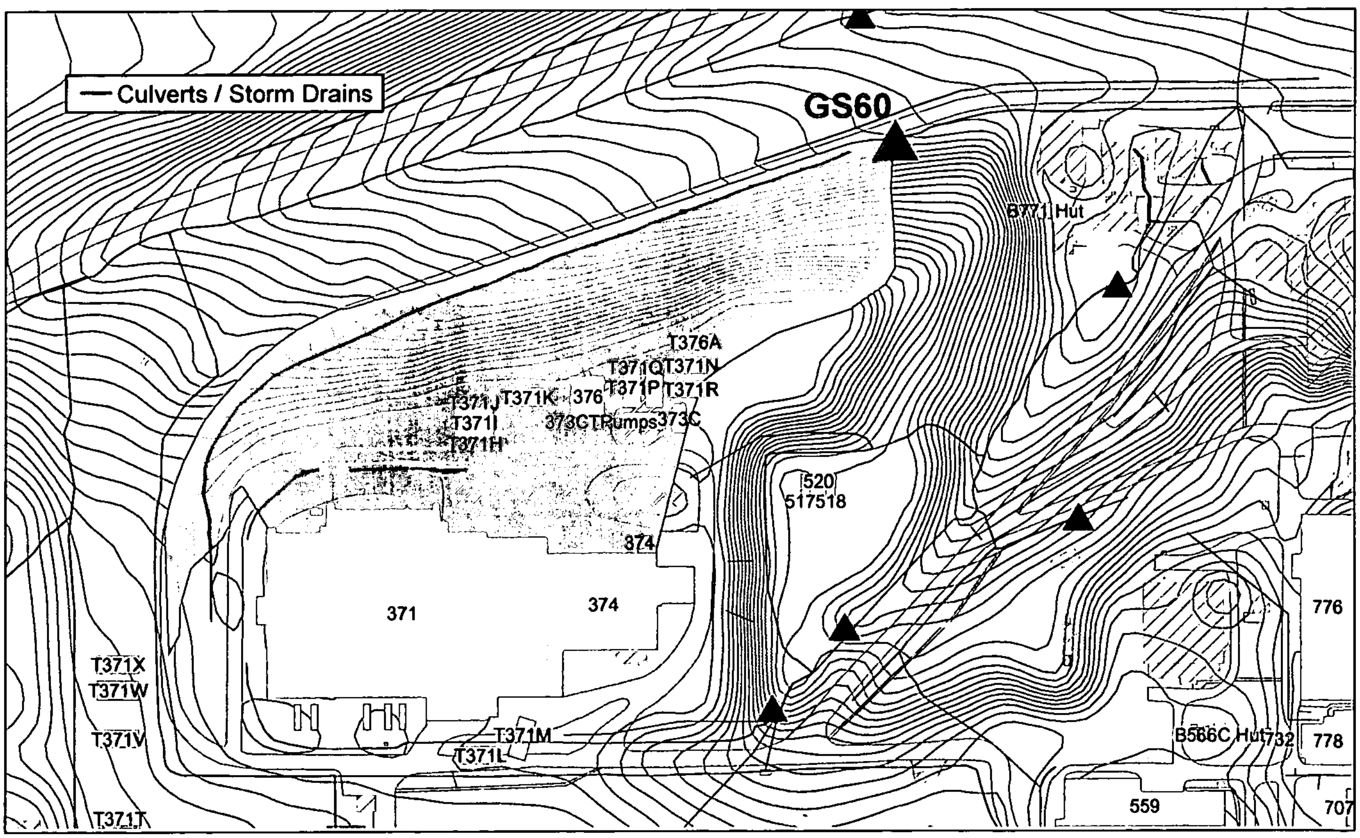


Figure 3-101. Map Showing GS60 Drainage Area.

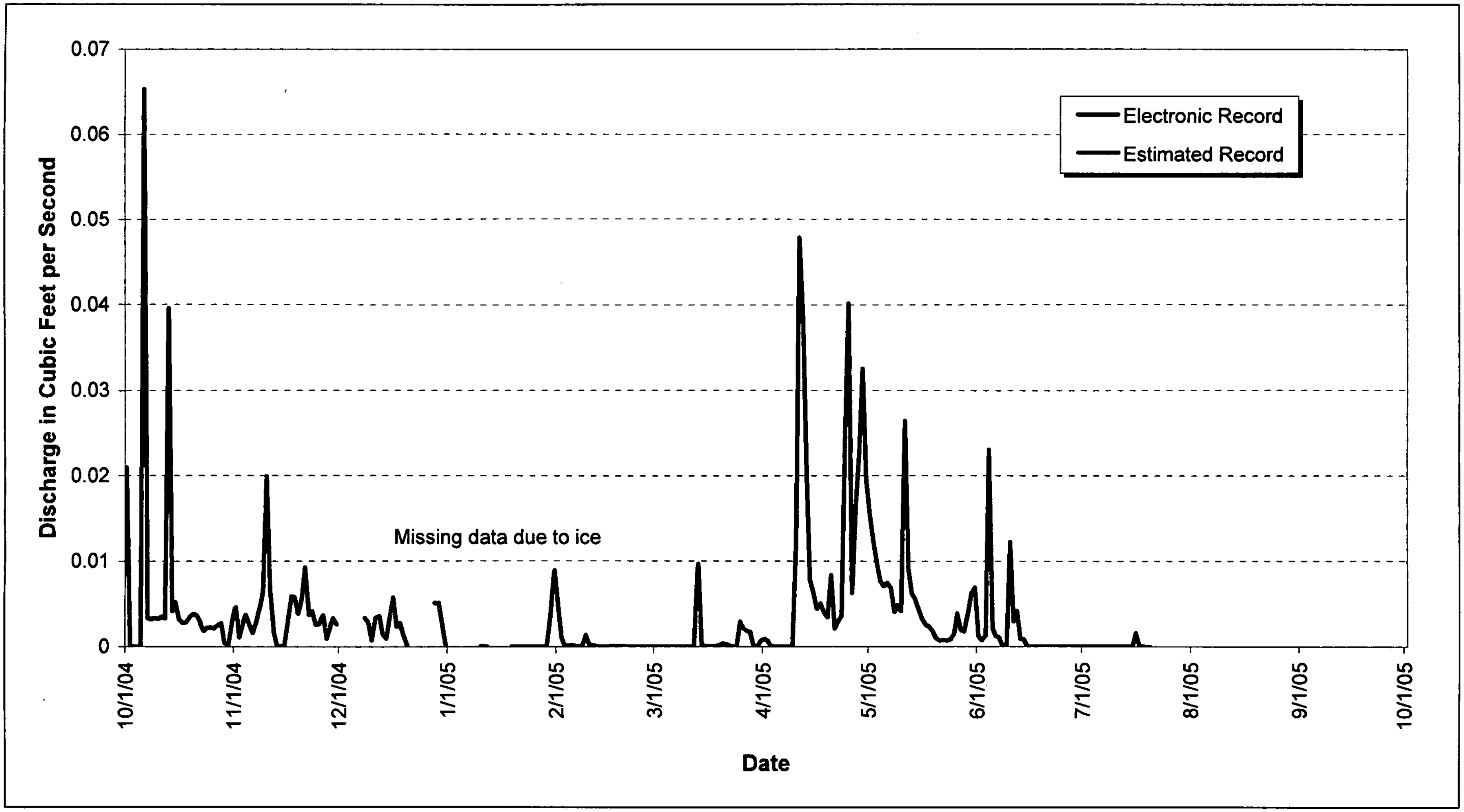


Figure 3-102. WY05 Mean Daily Hydrograph at GS60: Northern B371 Subdrainage Area.

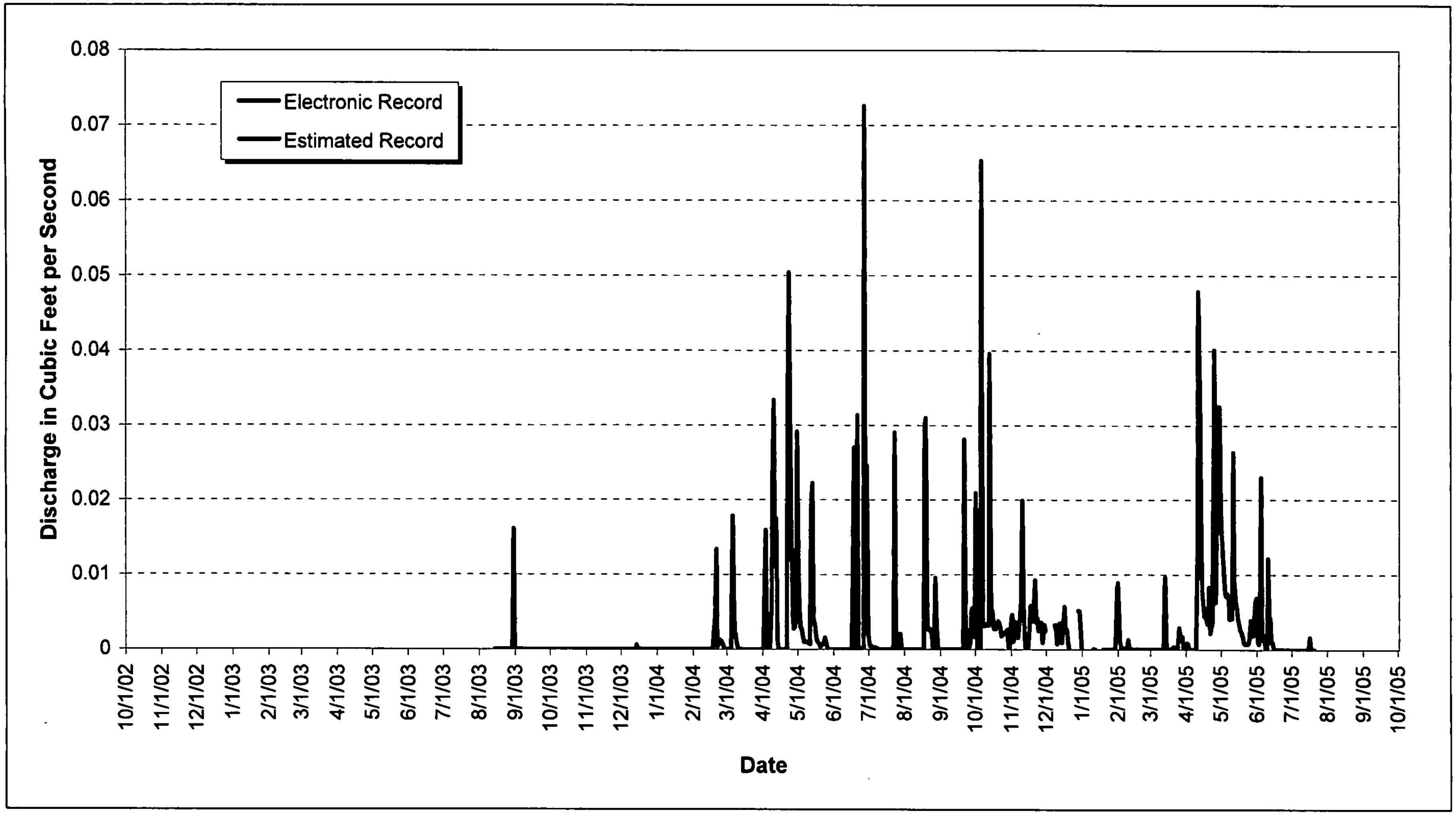


Figure 3-103. WY03-05 Mean Daily Hydrograph at GS60: Northern B371 Subdrainage Area.

3.2.35 GS61: Western 100 and 300 Drainage Area

Location

Drainage ditch southeast of B371 near 231 tanks; State Plane: E2082612, N750033

Moved 100' feet upstream on 4/7/05; sampling location code changed to GS61A

Drainage Area

- The basin includes areas tributary to N. Walnut Creek upstream of B371 (total of 50.5 acres)
- IA Areas draining to GS61: 100 and 300

Period of Record

10/30/03 to 8/22/05 (removed from service)

Gage

Water-stage recorder and 9" Montana flume

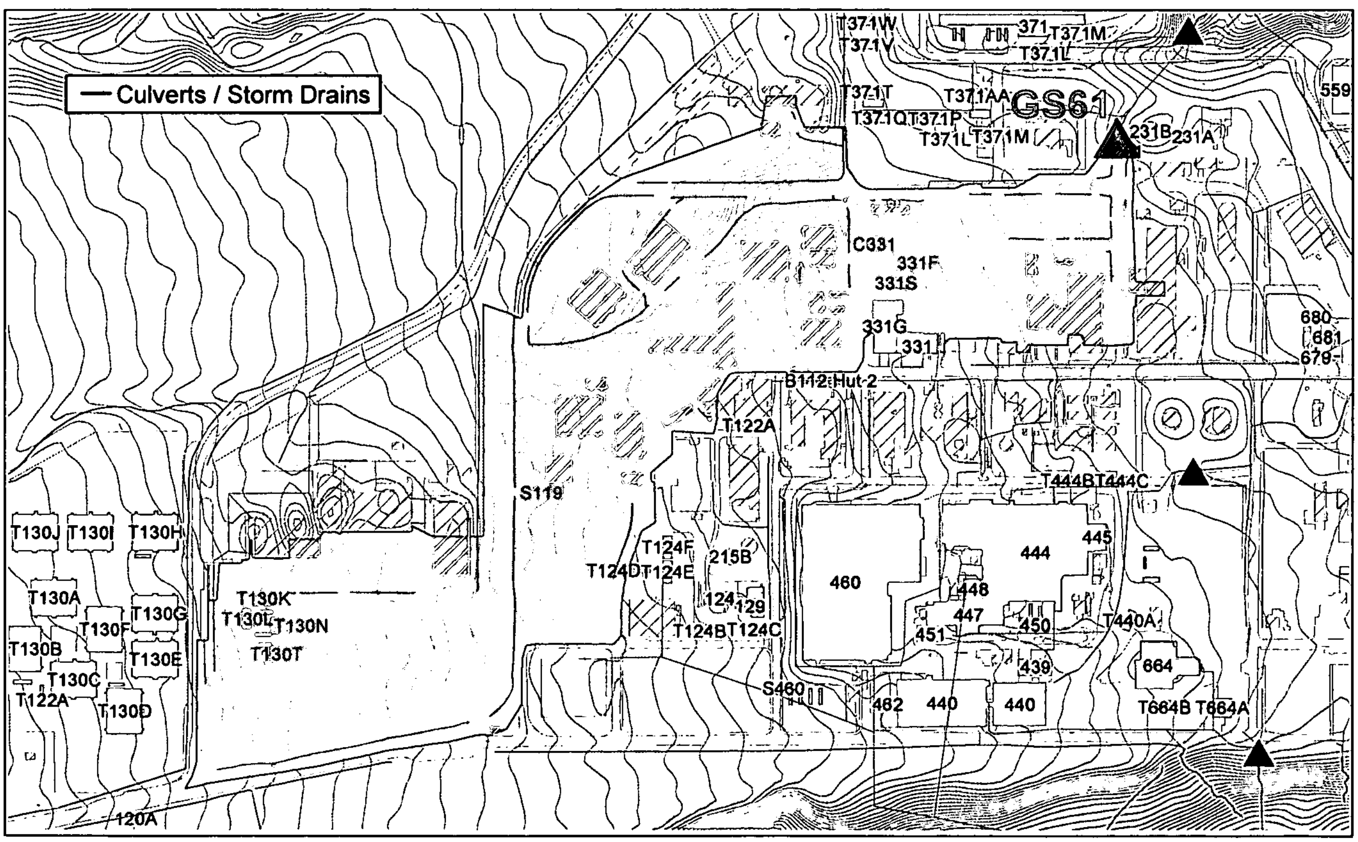


Figure 3-104. Map Showing GS61 Drainage Area.

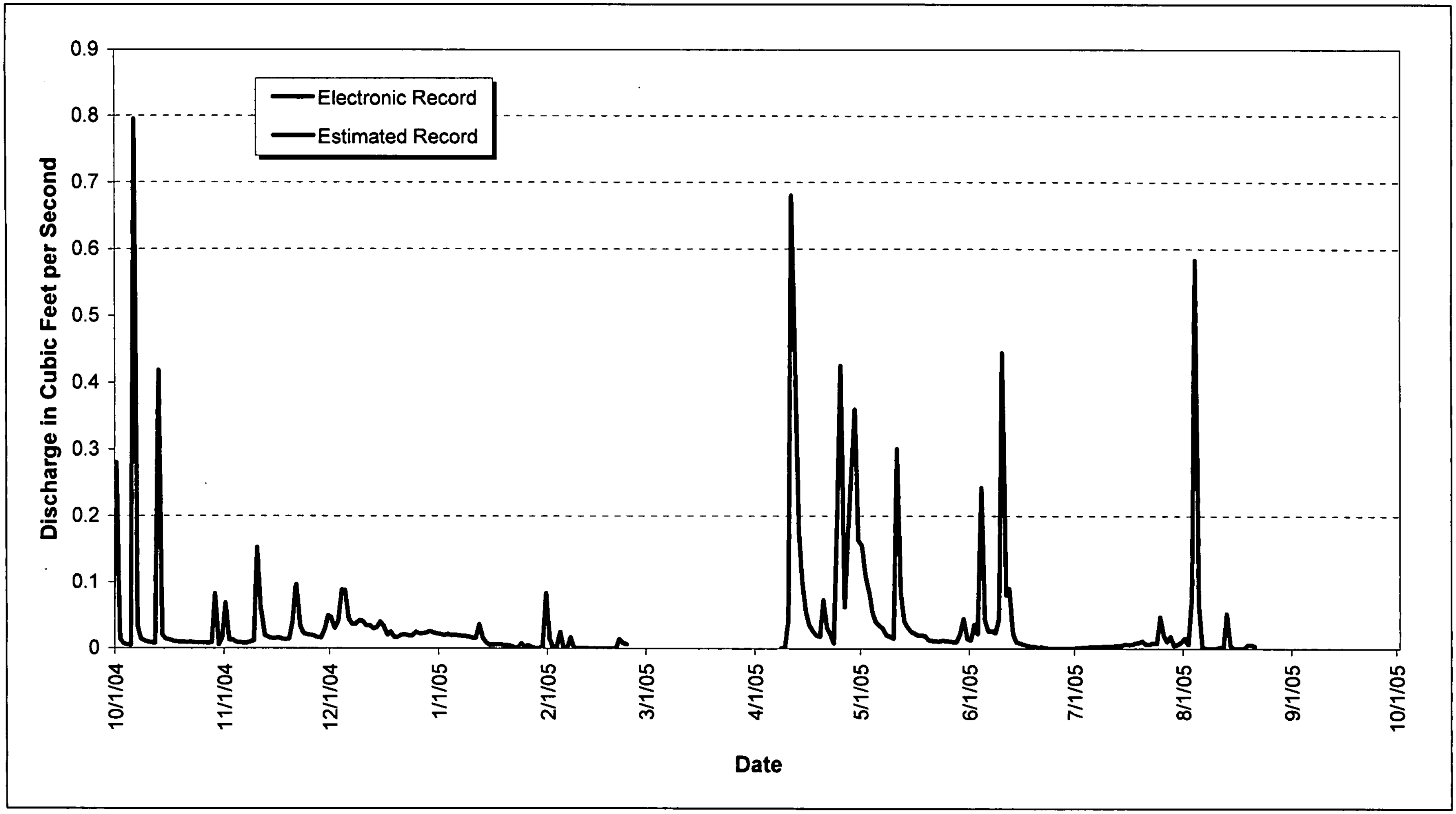


Figure 3-105. WY05 Mean Daily Hydrograph at GS61: Western 100 and 300 Drainage Area.

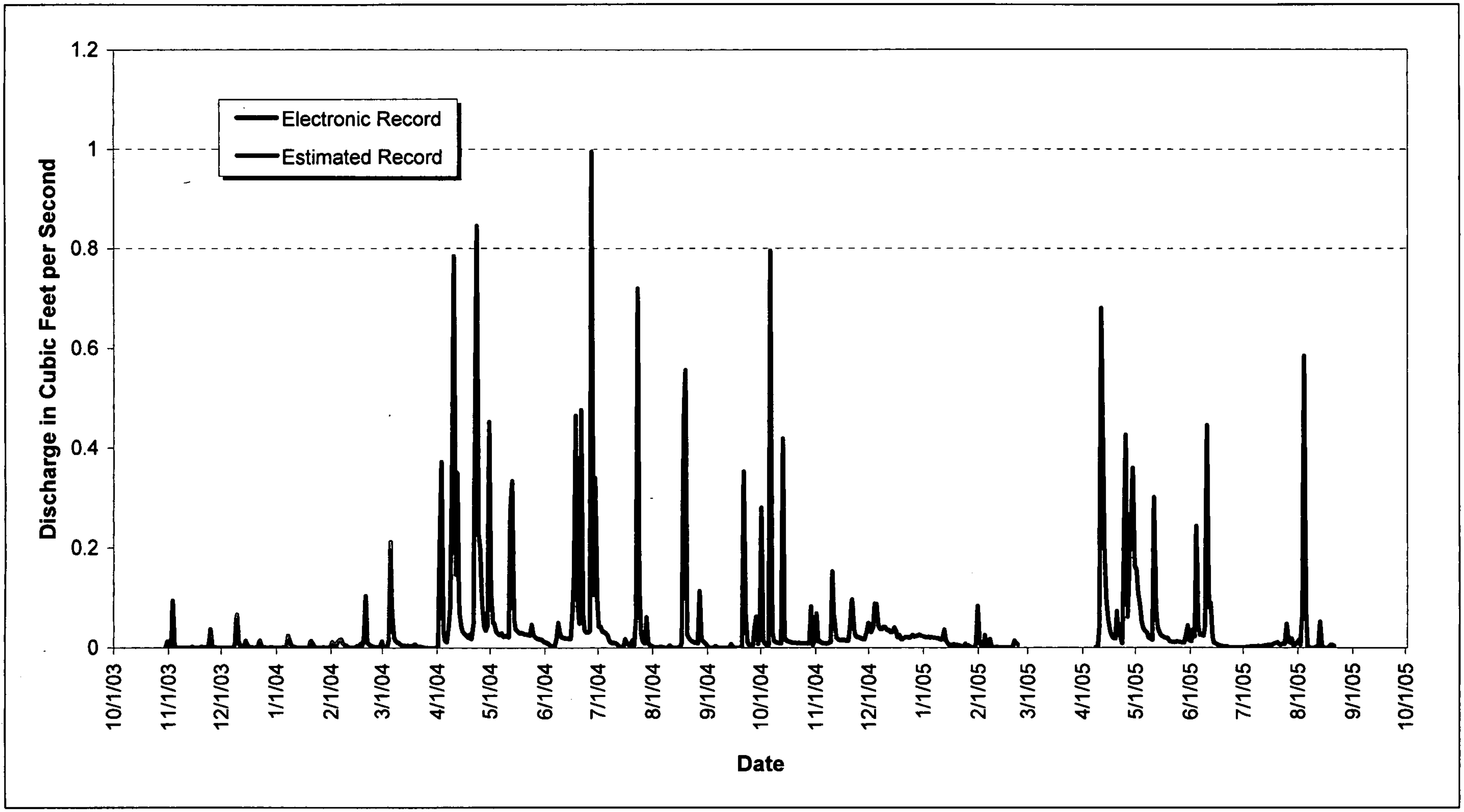


Figure 3-106. WY04-05 Mean Daily Hydrograph at GS61: Western 100 and 300 Drainage Area.

3.2.36 SW018: N. Walnut Creek Tributary East of B371

Location

N. Walnut Cr. tributary just upstream of cmp under former B771 trailers; State Plane: E2083351, N751006

Drainage Area

- The basin includes areas tributary to N. Walnut Creek upstream and including B371 (total of 80.2 acres)
- IA Areas draining to SW018: 100, 300, 500, and 700

Period of Record

10/10/03 to current year

Gage

Water-stage recorder and 1' Parshall flume

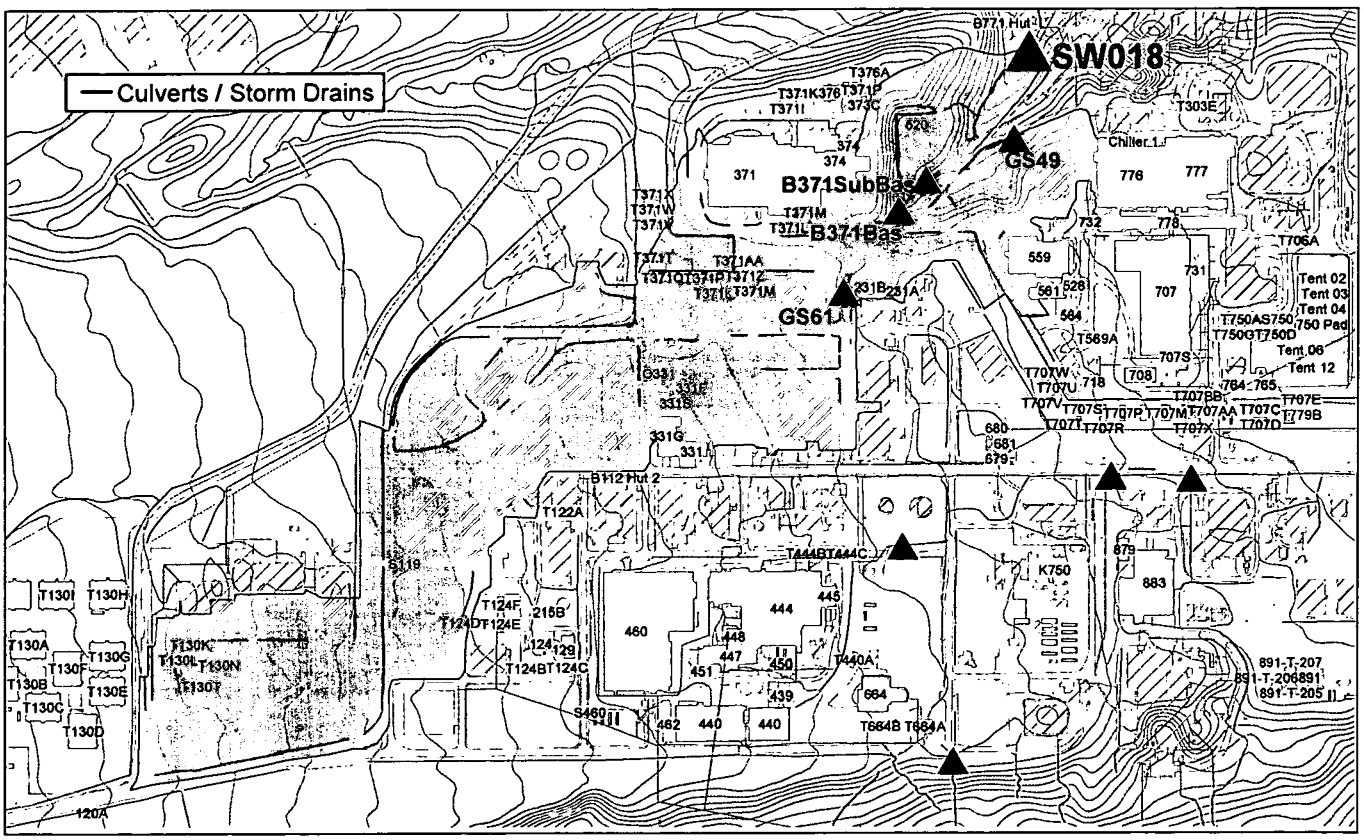


Figure 3-107. Map Showing SW018 Drainage Area.

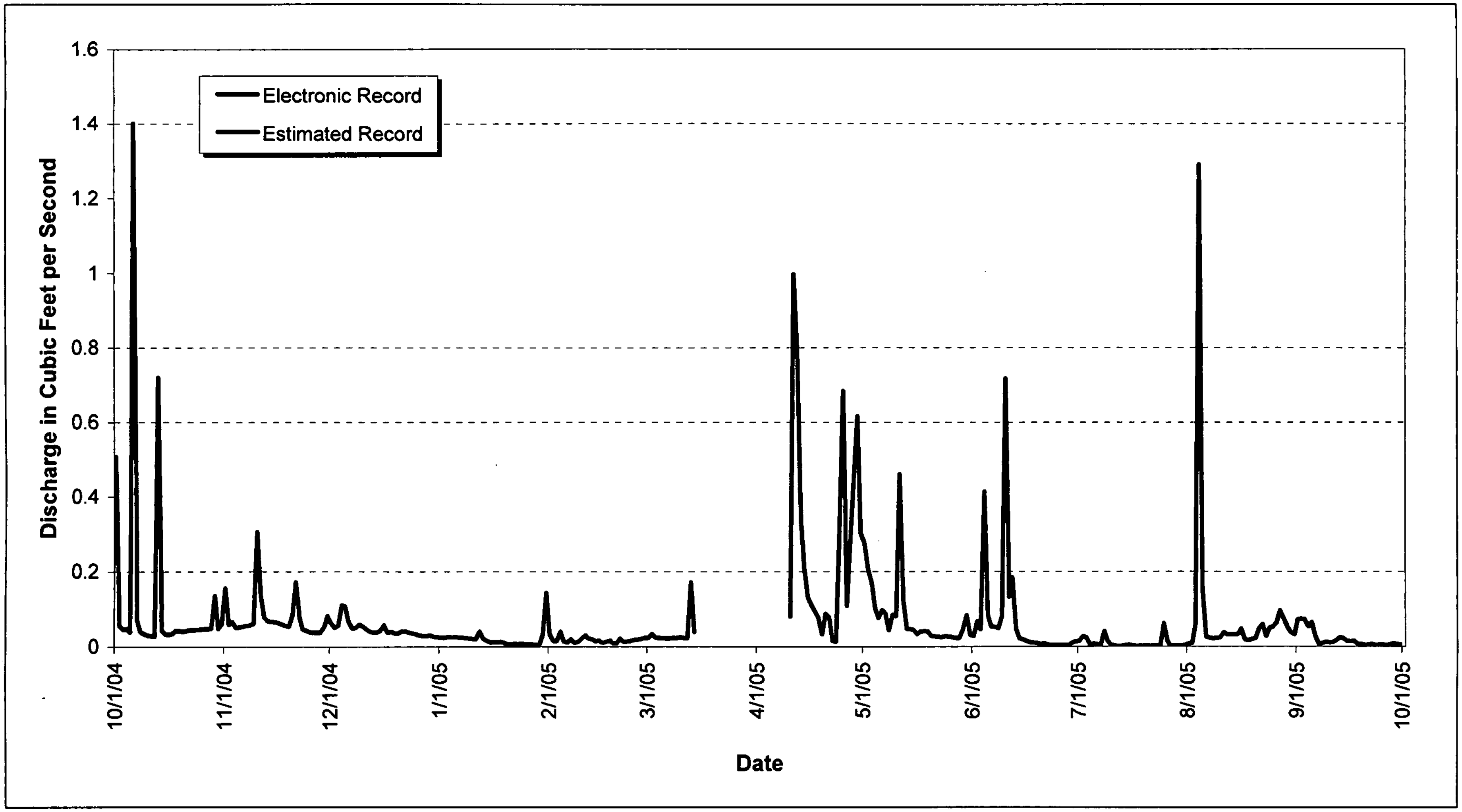


Figure 3-108. WY05 Mean Daily Hydrograph at SW018: N. Walnut Tributary Areas Upstream of and Including B371.

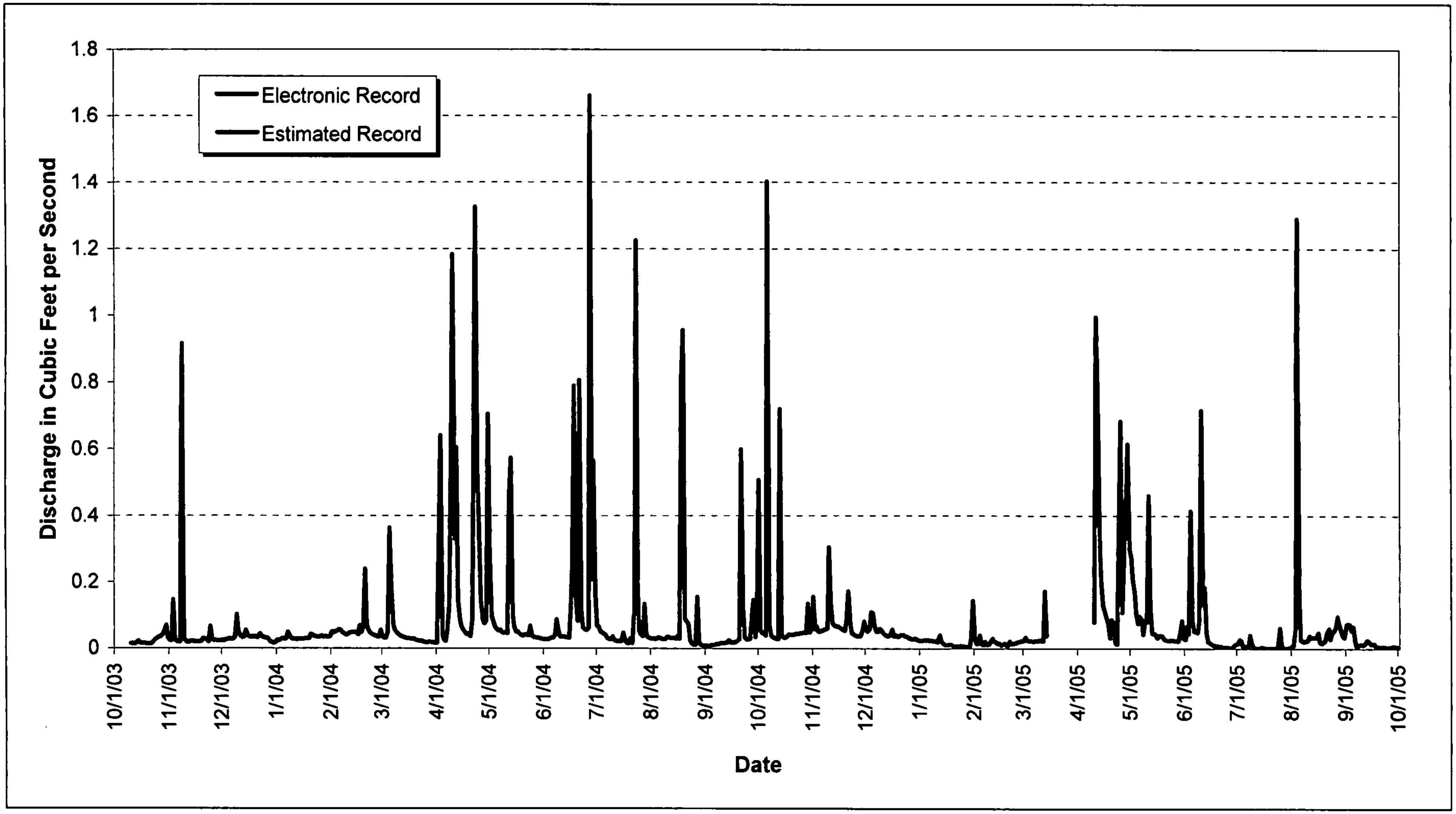


Figure 3-109. WY04-05 Mean Daily Hydrograph at SW018: N. Walnut Tributary Areas Upstream of and Including B371.

3.2.37 SW021: B991 Subdrainage Area

Location

Concrete pipe draining B991 and Solar Ponds area; State Plane: E2086077, N750187

Drainage Area

- The basin includes most of the B991 area and portions of the Solar Ponds area (total of 25 acres)
- IA Areas draining to SW021: 900

Period of Record

5/6/03 to 12/6/04 (removed from service)

Gage

Water-stage recorder and 1.5' H-flume

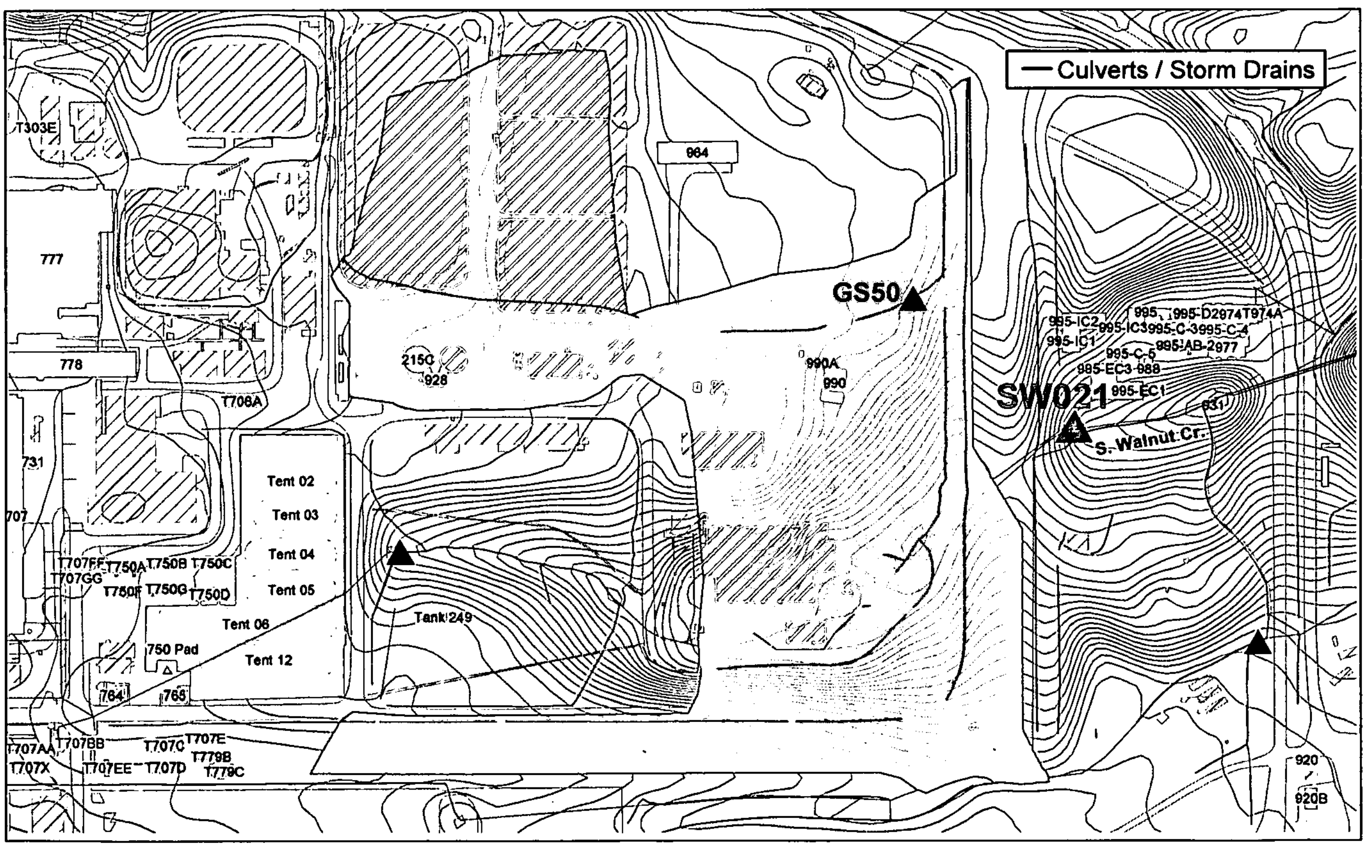


Figure 3-110. Map Showing SW021 Drainage Area.

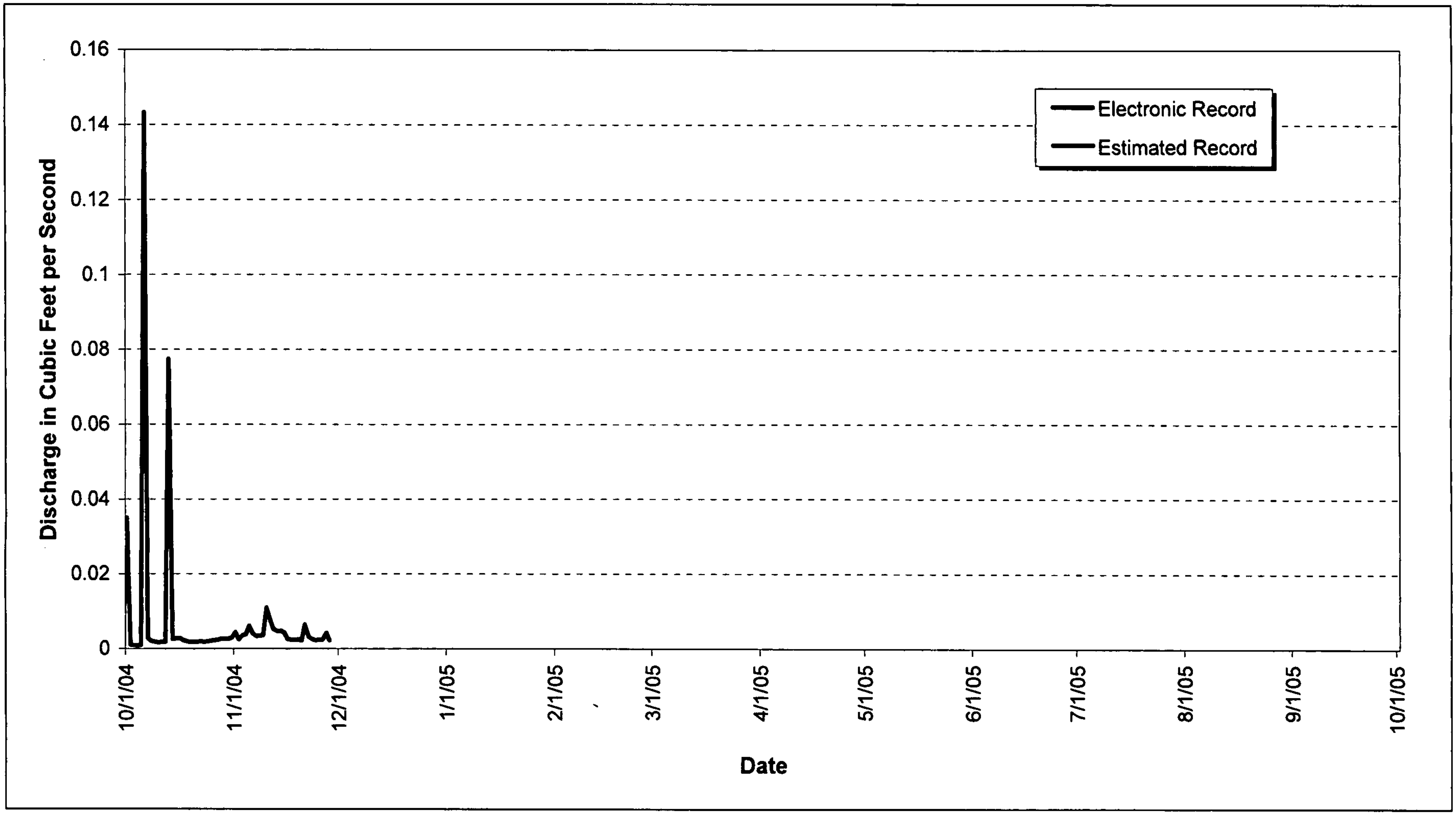


Figure 3-111. WY05 Mean Daily Hydrograph at SW021: B991 Subdrainage Area.

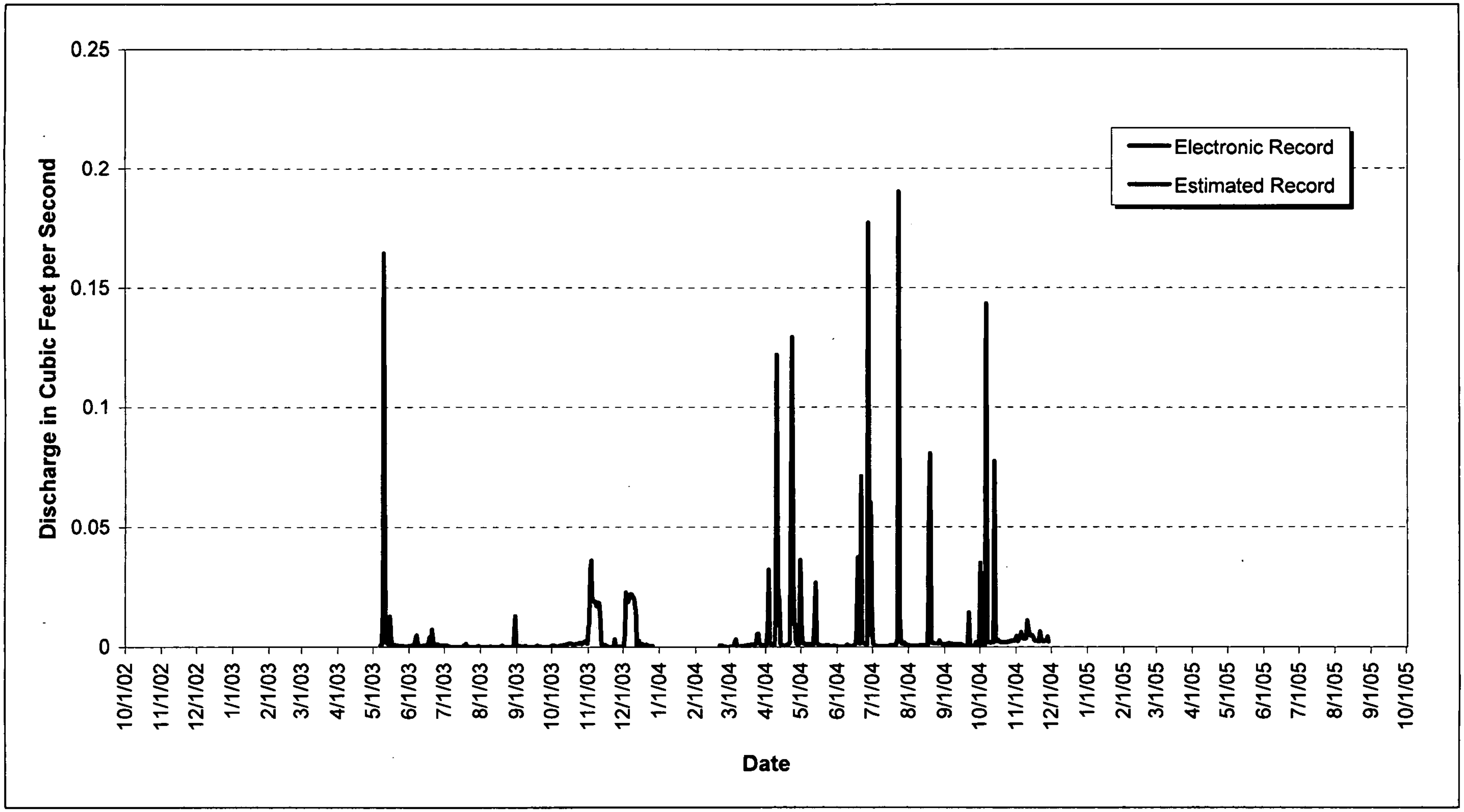


Figure 3-112. WY03-05 Mean Daily Hydrograph at SW021: B991 Subdrainage Area.

3.2.38 SW022: East End of Central Avenue Ditch

Location

East end of Central Avenue Ditch; State Plane: E2086438, N749759

Drainage Area

- The basin includes the IA south of Central Avenue Ditch (total of 76.1 acres)
- IA Areas draining to SW022: 900, 800, 600, 400, and 100

Period of Record

9/11/91 to 4/17/05 (removed from service)

Gage

Water-stage recorder and 9.5" Parshall flume

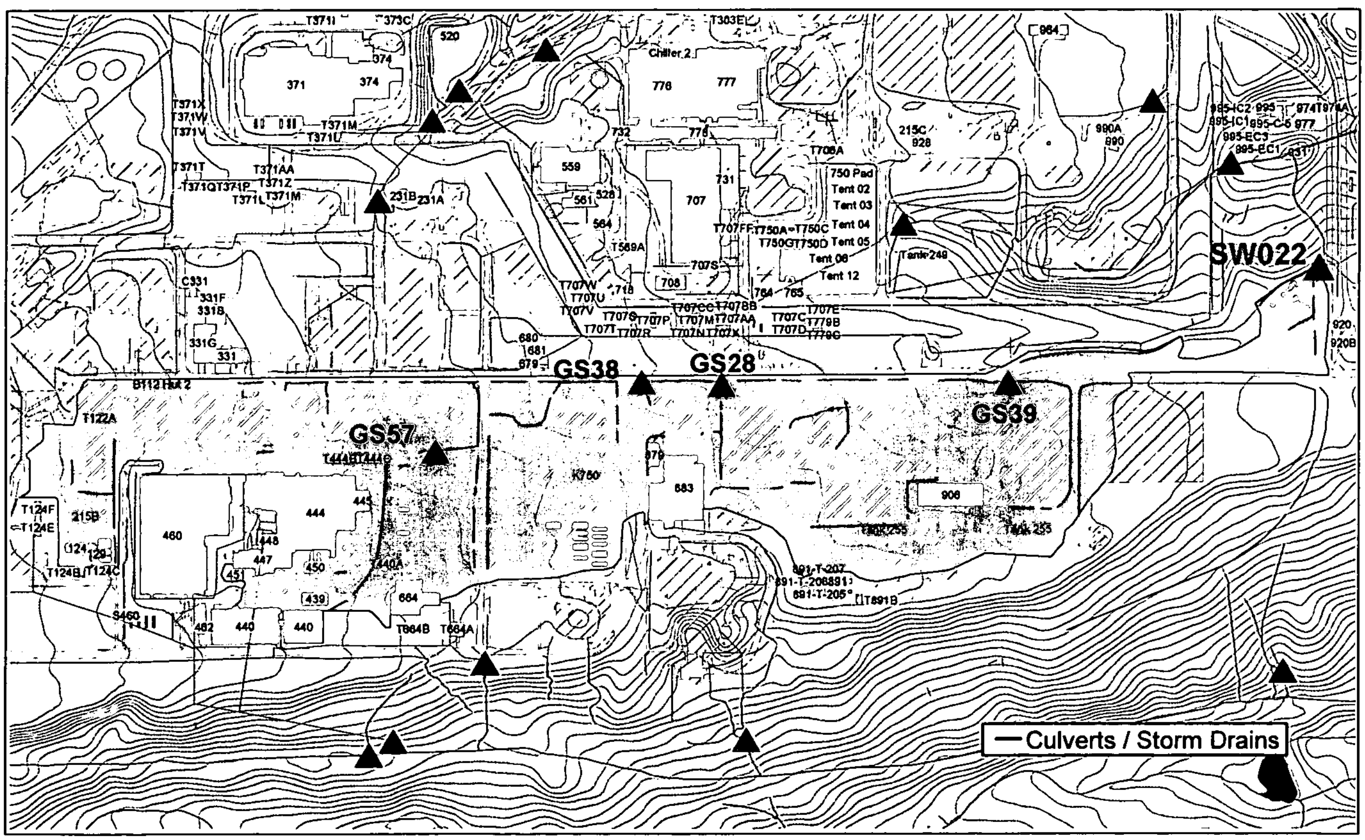


Figure 3-113. Map Showing SW022 Drainage Area.

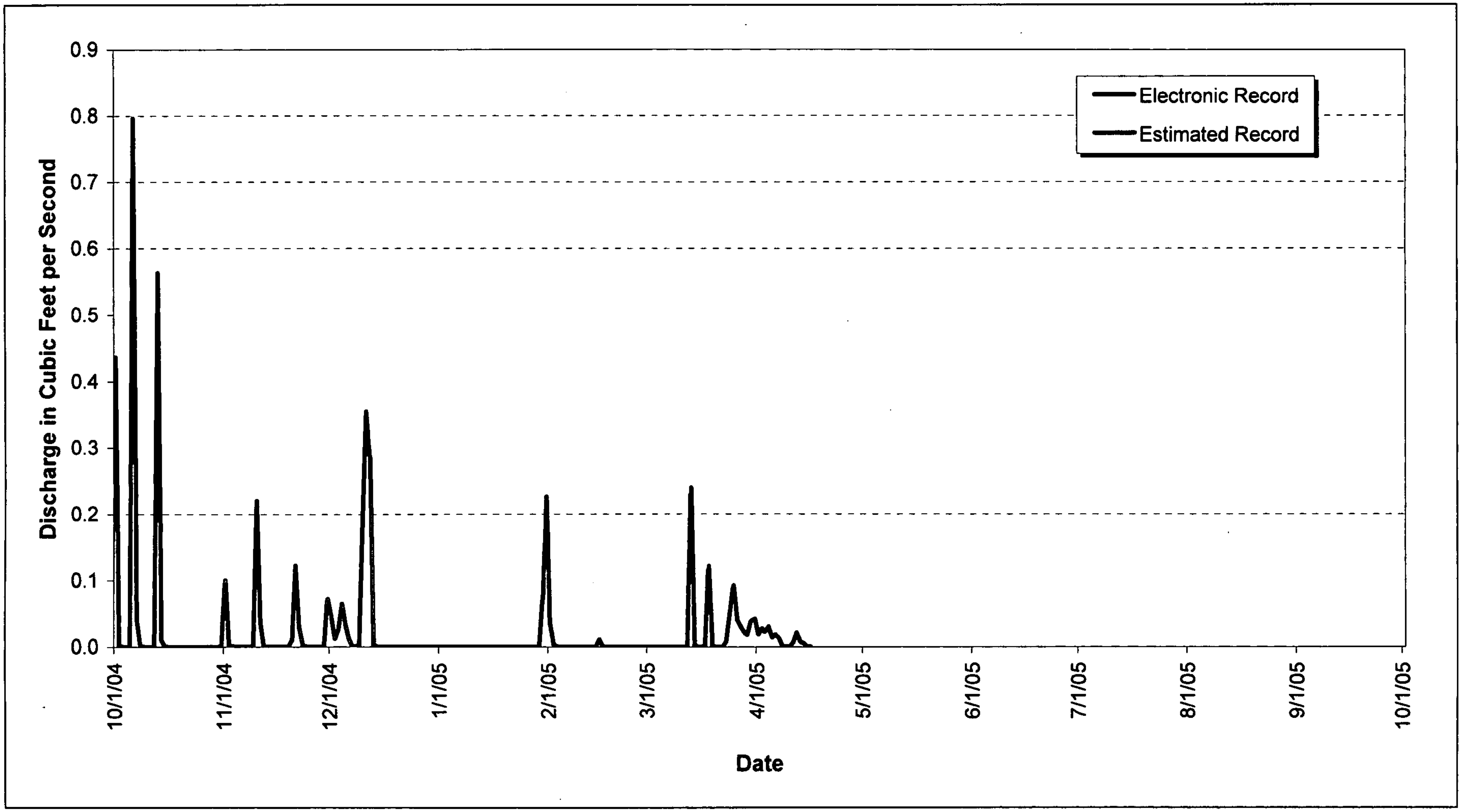


Figure 3-114. WY05 Mean Daily Hydrograph at SW022: East End of Central Avenue Ditch.

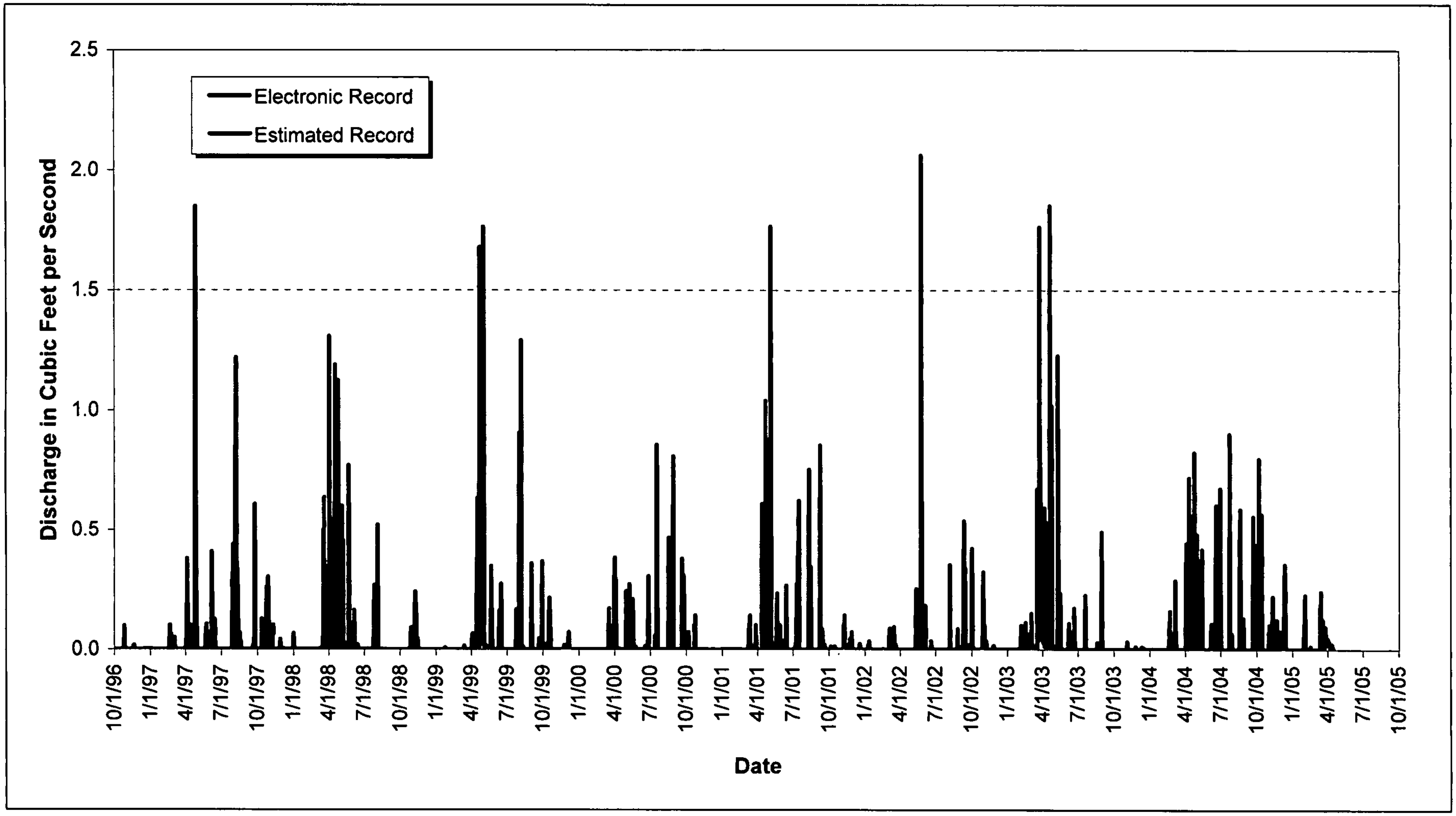


Figure 3-115. WY97-05 Mean Daily Hydrograph at SW022: East End of Central Avenue Ditch.

3.2.39 SW027: SID at Pond C-2

Location

East end of SID at Pond C-2; State Plane: E2088515, N748067

Drainage Area

- The basin includes the a portion of the southern IA and the area east of the inner fence and south of the East Access Rd. (total of 215.9 acres)
- IA Areas draining to SW027: 900, 800, 600, and 400

Period of Record

9/11/91 to current year

Gage

Water-stage recorder and dual, parallel 120° V-notch weirs

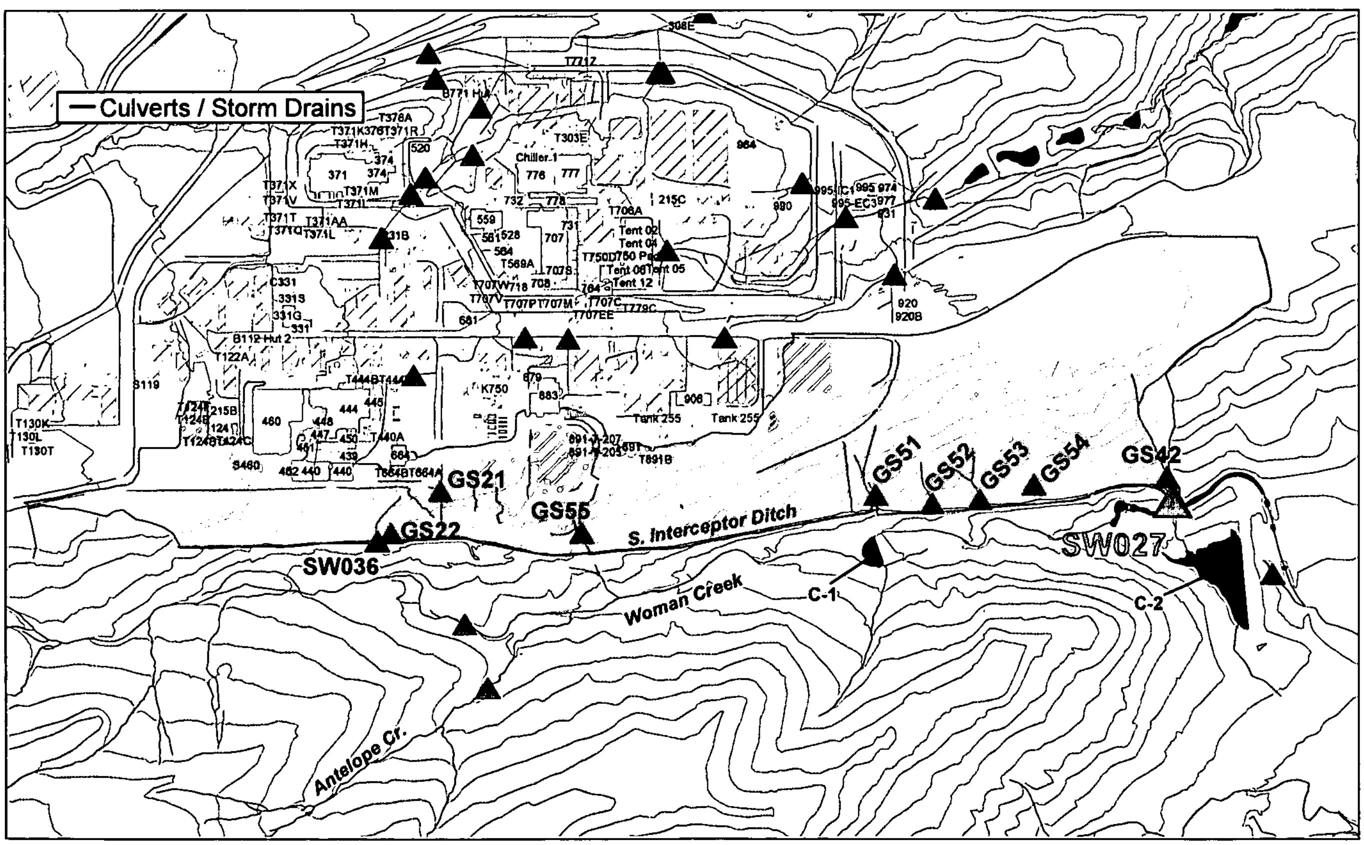


Figure 3-116. Map Showing SW027 Drainage Area.

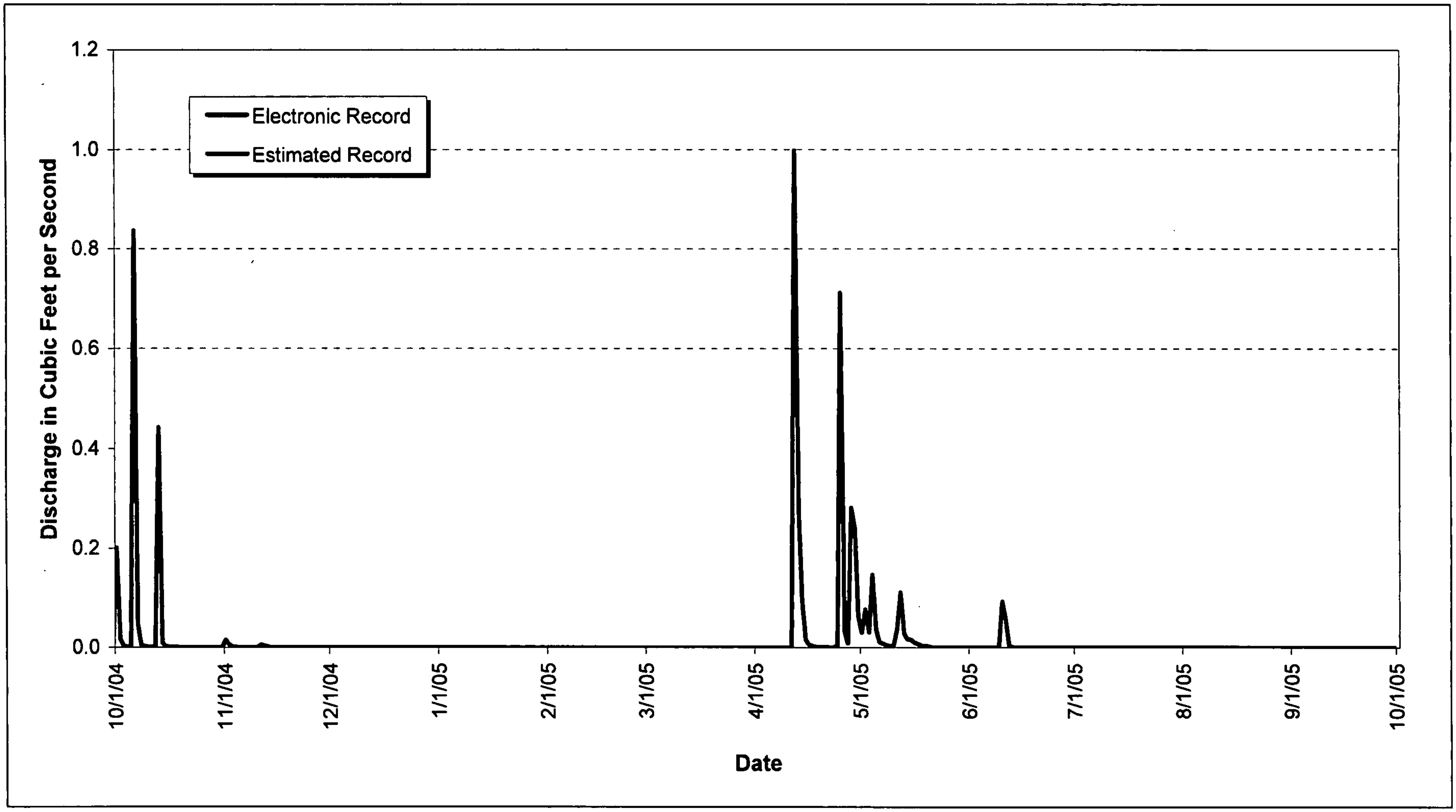


Figure 3-117. WY05 Mean Daily Hydrograph at SW027: SID at Pond C-2.

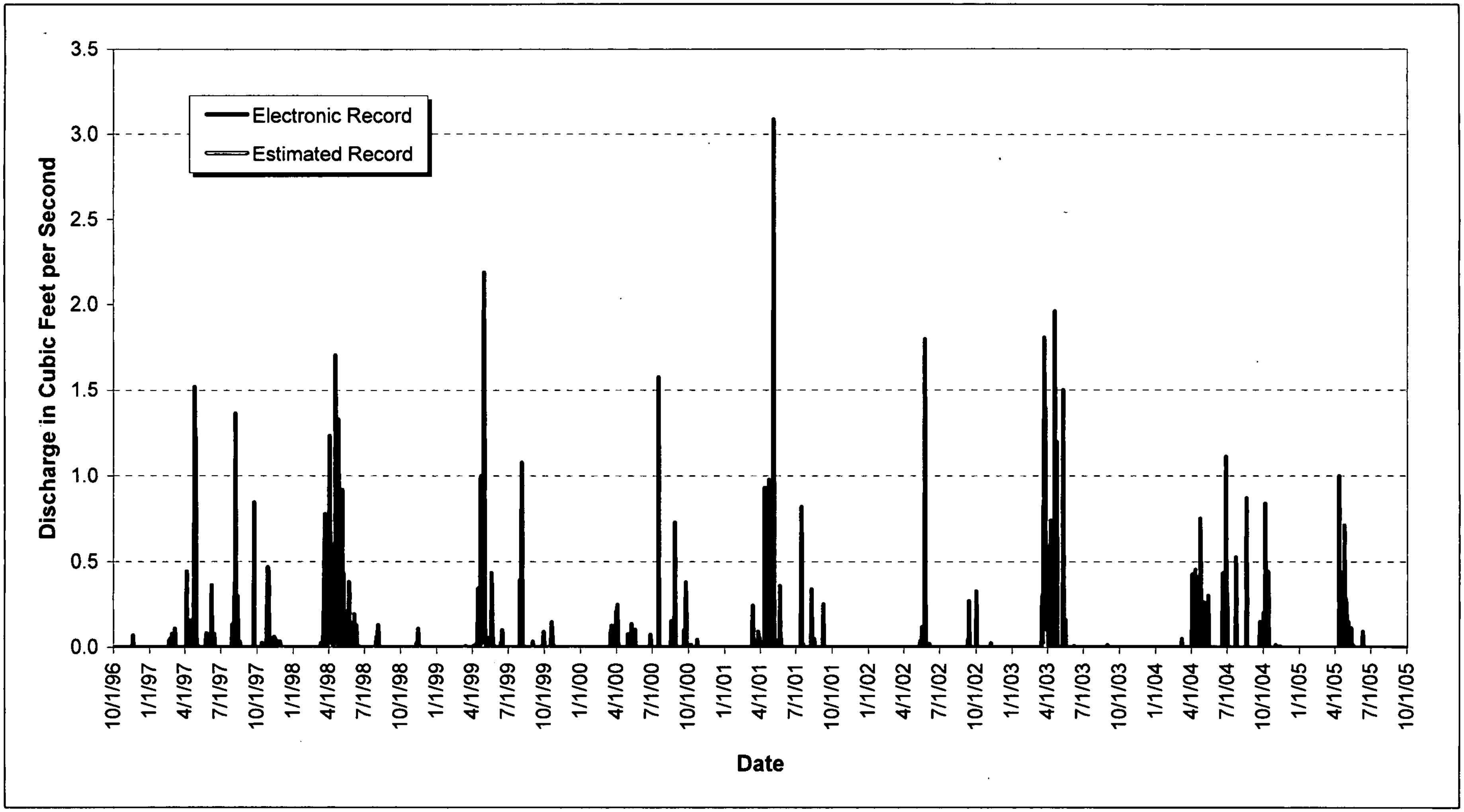


Figure 3-118. WY97-05 Mean Daily Hydrograph at SW027: SID at Pond C-2.

3.2.40 SW036: SID South of B664 Upstream of 400 Area Outfall

Location

SID 500 feet downstream of Original Landfill; State Plane: E2082579, N747762

Drainage Area

- The basin includes the majority of the hillside south of the 400 Area north of the SID (total of 16.4 acres)
- IA Areas draining to SW036: None

Period of Record

6/13/02 to 3/17/05 (removed from service)

Gage

Water-stage recorder and 6" Parshall flume

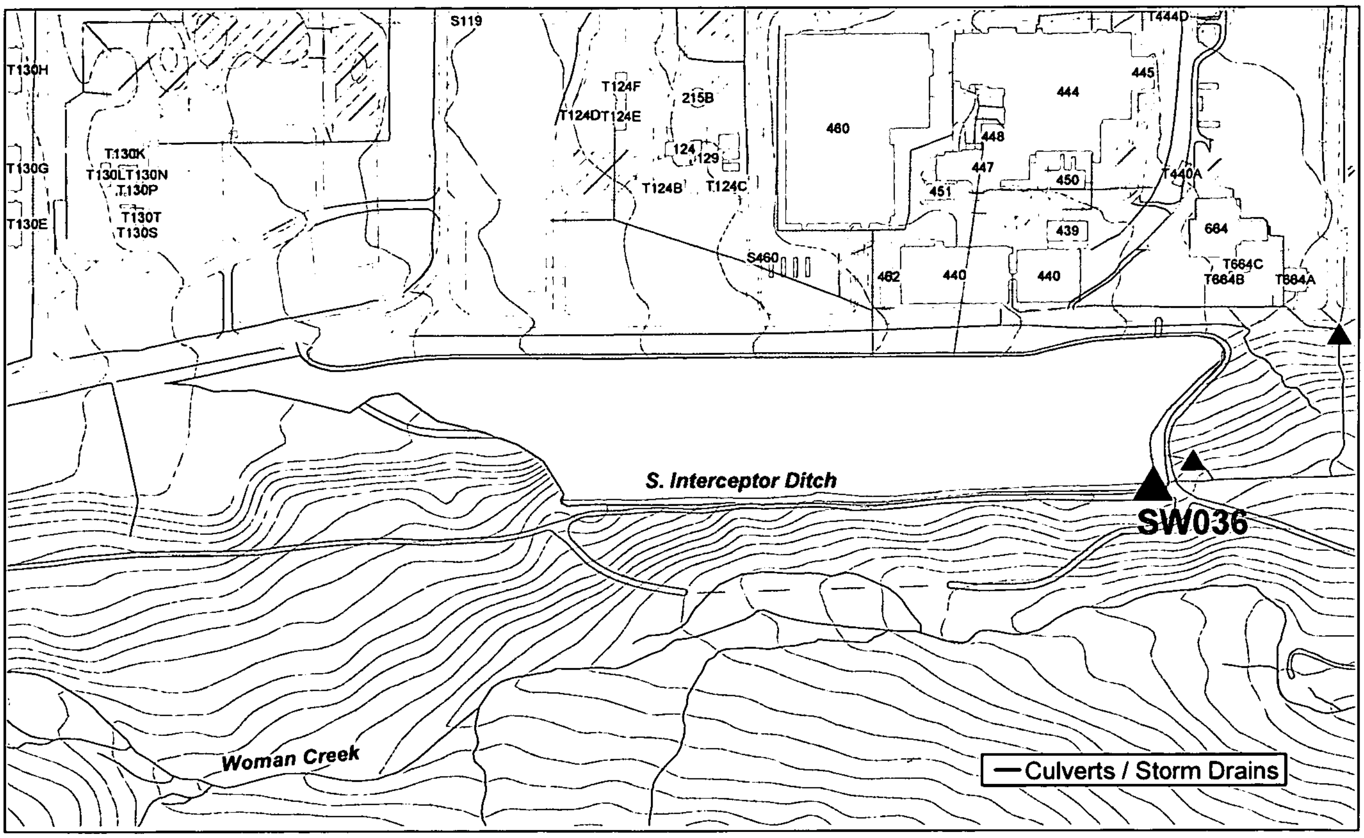


Figure 3-119. Map Showing SW036 Drainage Area.

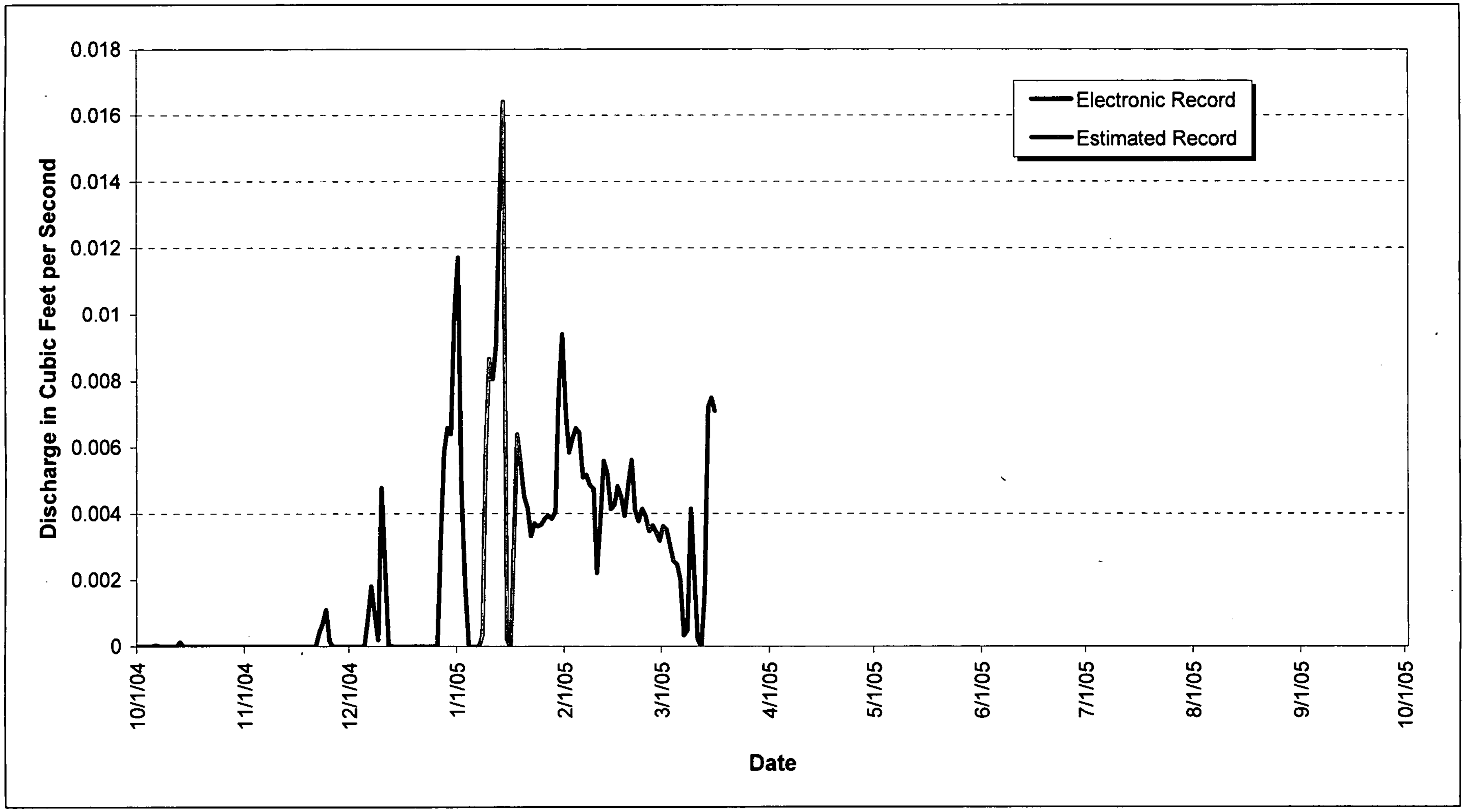


Figure 3-120. WY05 Mean Daily Hydrograph at SW036: SID South of B664 Upstream of 400 Area Outfall.

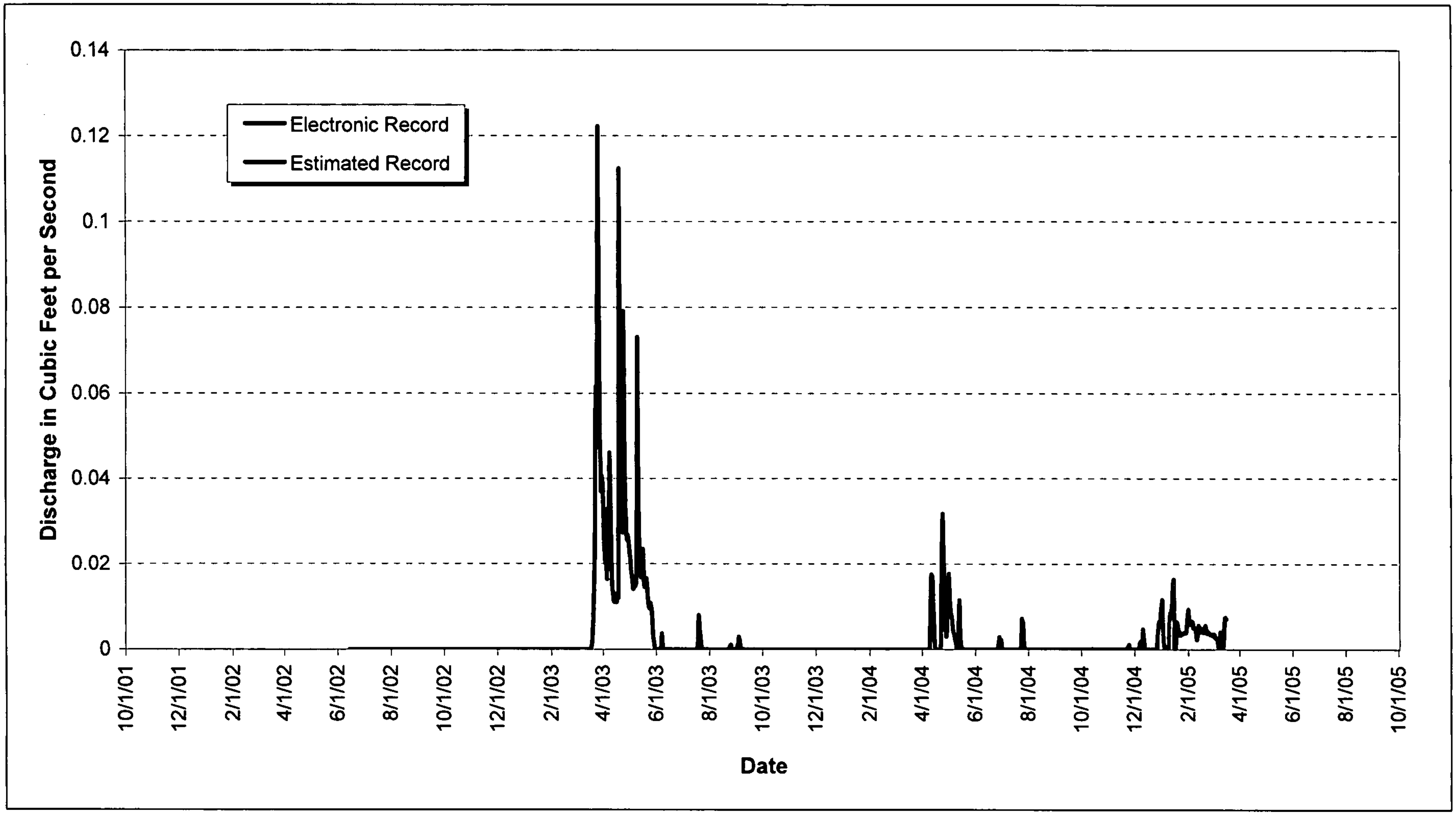


Figure 3-121. WY02-05 Mean Daily Hydrograph at SW036: SID South of B664 Upstream of 400 Area Outfall.

3.2.41 SW091: North Walnut Creek Tributary Northeast of Solar Ponds

Location

North Walnut Creek tributary draining area northeast of Solar Ponds; State Plane: E2086267, N751775

Drainage Area

- The basin includes the area northeast of the Solar Ponds (total of 9.9 acres)
- IA Areas draining to SW091: 900

Period of Record

4/18/95 to 9/7/05 (removed from service)

Gage

Water-stage recorder and 6" cutthroat flume; 1.5' H-flume located 400 feet upstream prior to 5/4/98.

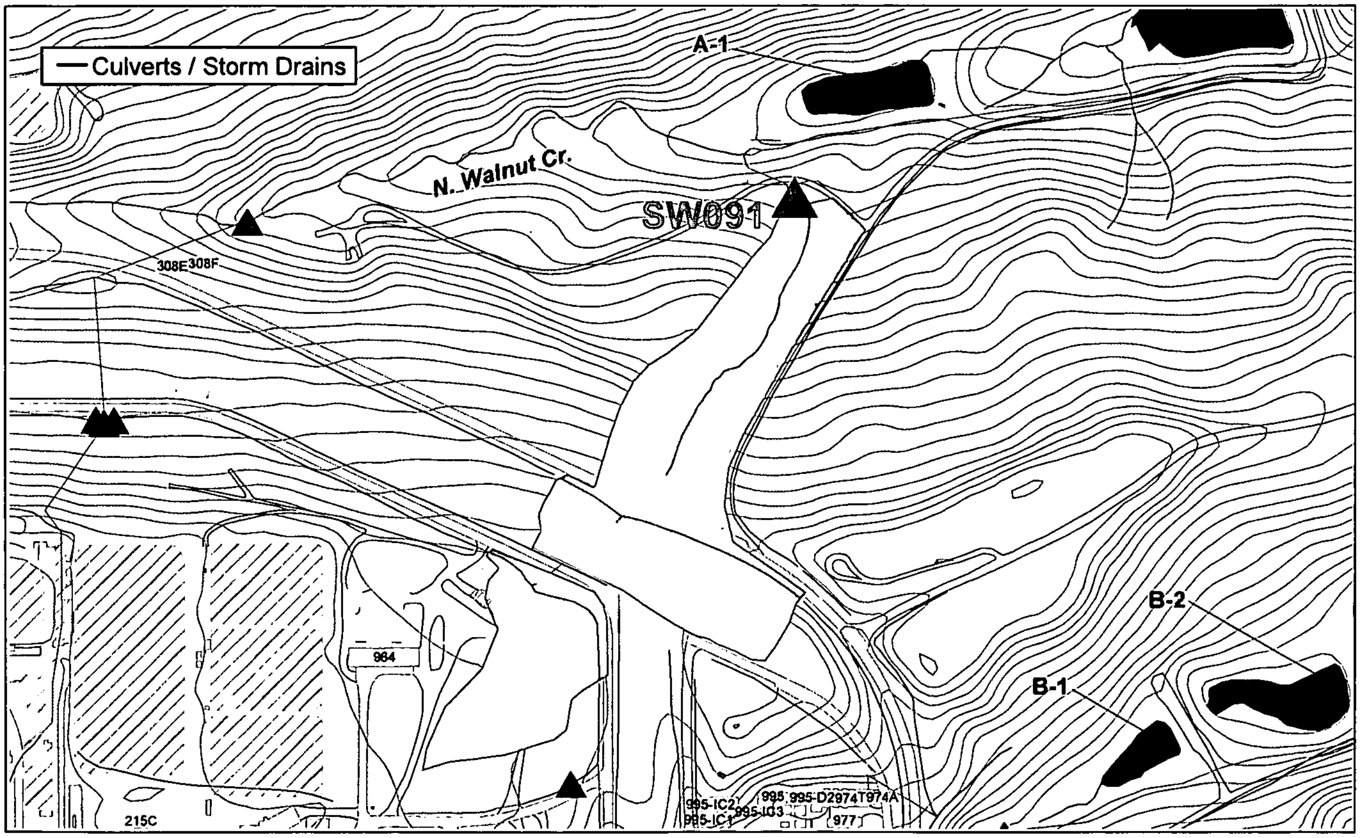


Figure 3-122. Map Showing SW091 Drainage Area.

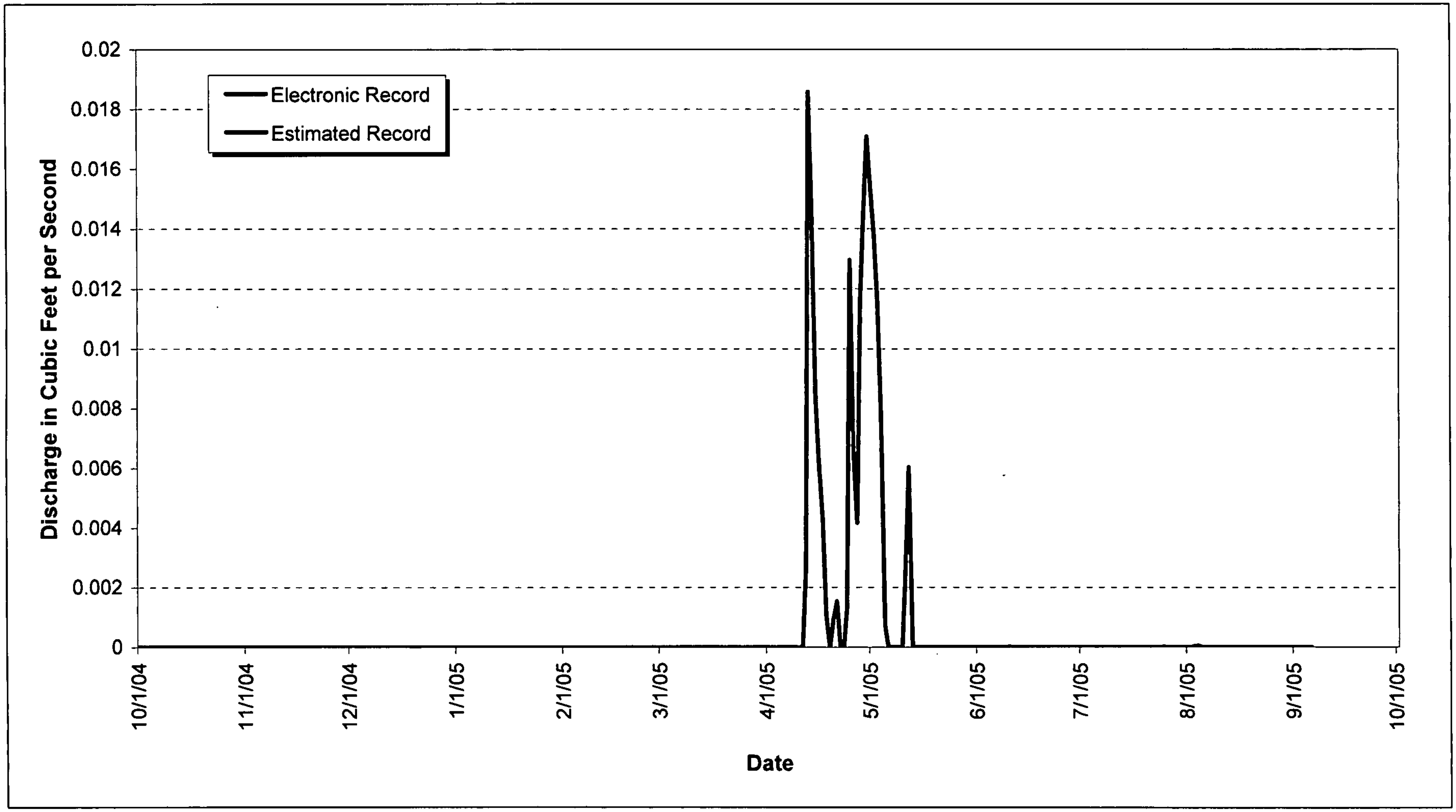


Figure 3-123. WY05 Mean Daily Hydrograph at SW091: North Walnut Creek Tributary Northeast of Solar Ponds.

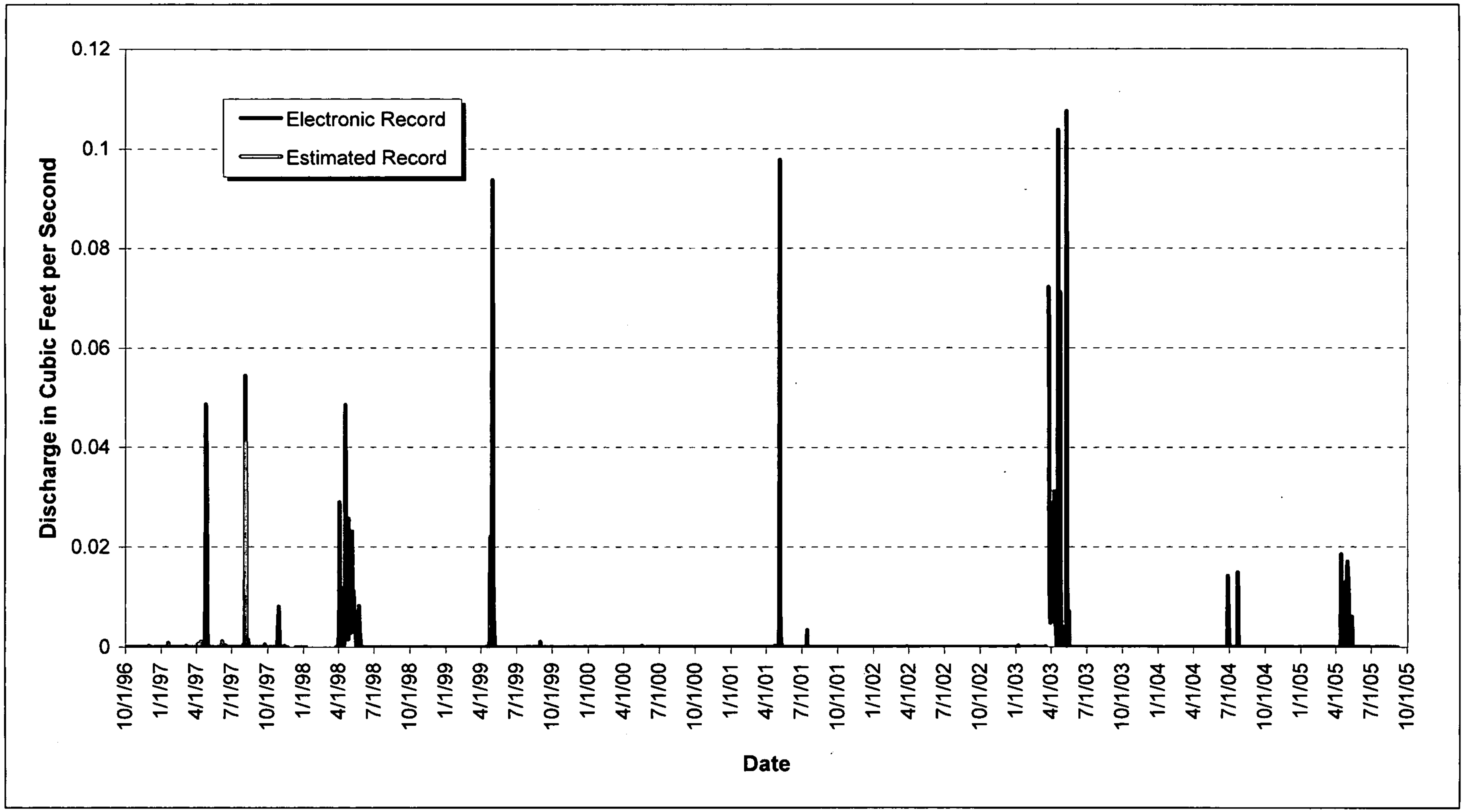


Figure 3-124. WY97-05 Mean Daily Hydrograph at SW091: North Walnut Creek Tributary Northeast of Solar Ponds.

3.2.42 SW093: North Walnut Creek 1300' Upstream of A-1 Bypass

Location

North Walnut Creek 1300' above A-1 Bypass; State Plane: E2085026, N751720

Drainage Area

- The basin includes the northern portion of the PA and portions of the western IA south (total of 242.7 acres)
- IA Areas draining to SW093: 900, 700, 500, 300, and 100

Period of Record

9/11/91 to current year

Gage

Water-stage recorder and 36" suppressed, rectangular, sharp-crested weir to 1/27/03; rated stream section during new flume construction (SW093T; 1/27/03-5/29/03). Three-foot H flume starting 5/29/03

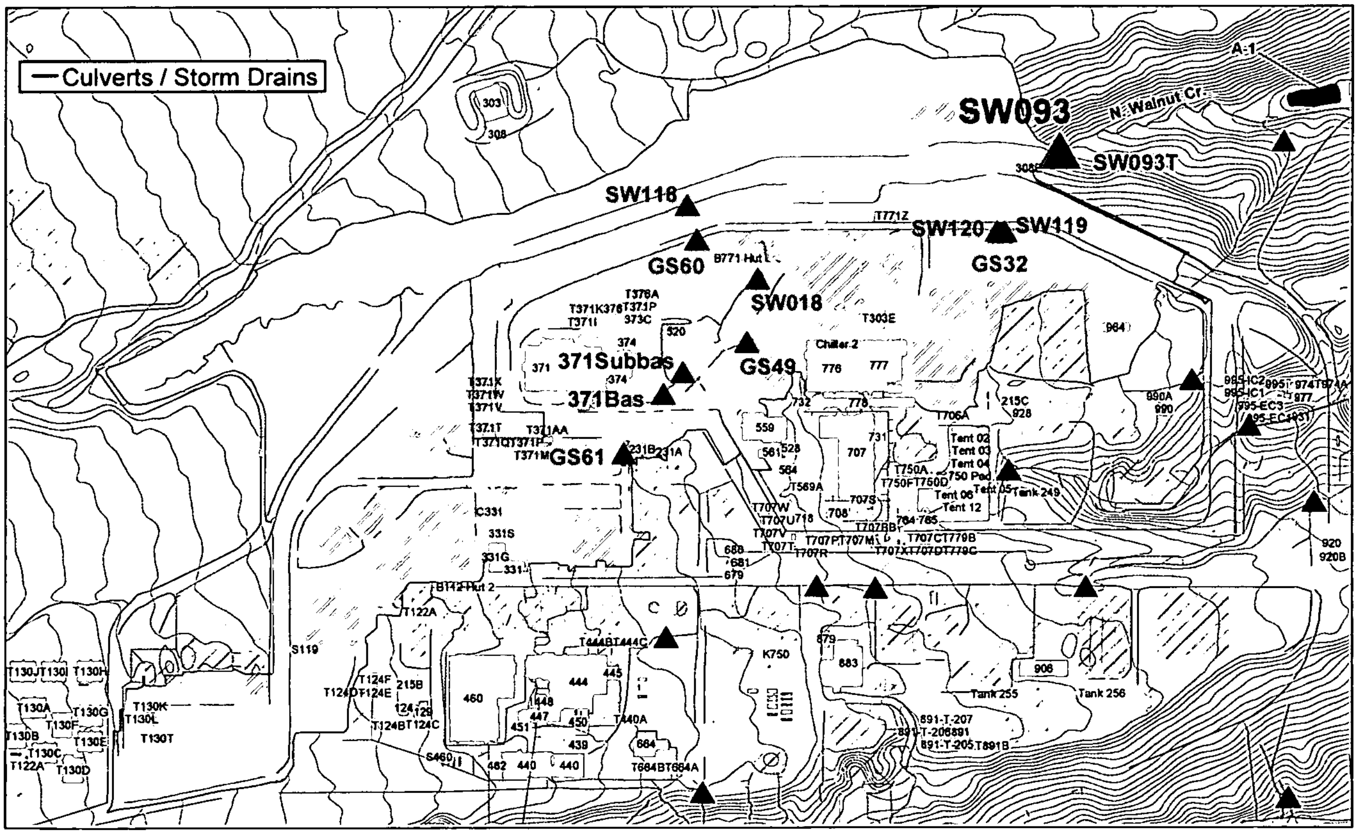


Figure 3-125. Map Showing SW093 Drainage Area.

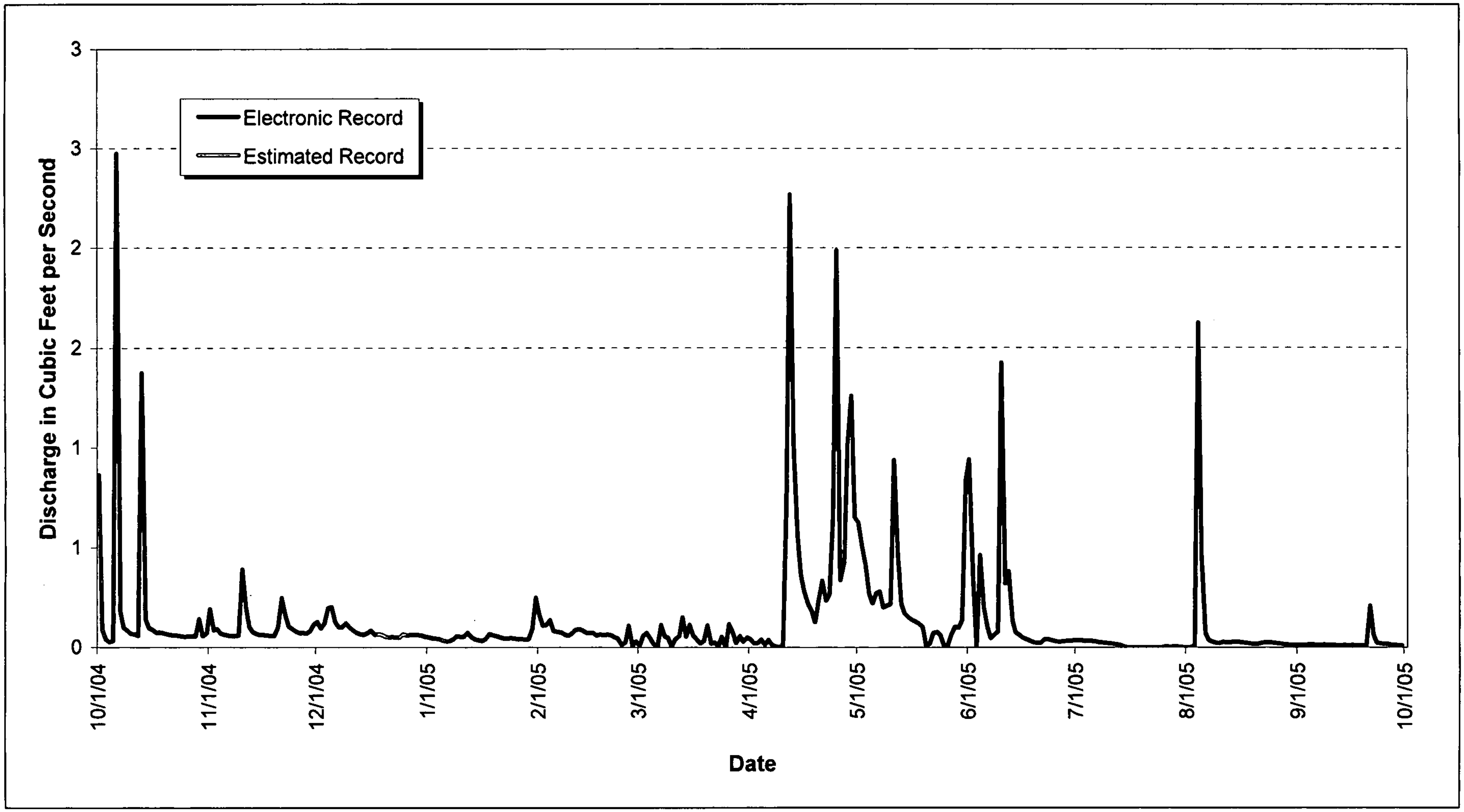


Figure 3-126. WY05 Mean Daily Hydrograph at SW093: North Walnut Creek Upstream of A-1 Bypass.

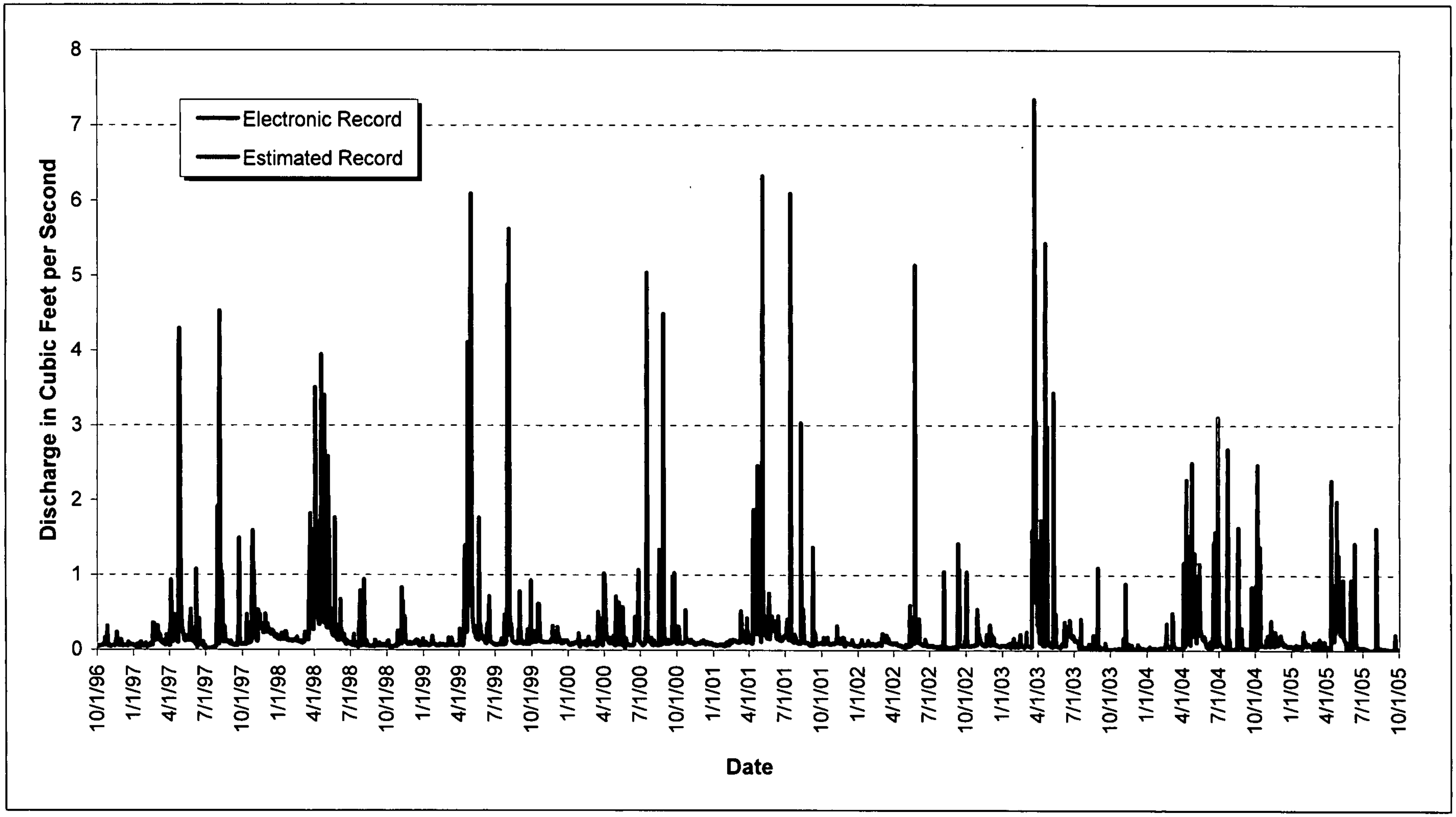


Figure 3-127. WY97-05 Mean Daily Hydrograph at SW093: North Walnut Creek Upstream of A-1 Bypass.

3.2.43 SW118: North Walnut Creek 560' Upstream of Portal 3

Location

North Walnut Creek west of Portal 3; State Plane: E2082961, N751417

Drainage Area

- The basin includes the North Walnut Creek drainage west of the PA and downstream of the West Diversion Ditch (total of 50.3 acres)
- IA areas draining to SW118: 300

Period of Record

9/11/91 to 7/21/05 (removed from service)

Gage

Water-stage recorder 169.5° V-notch weir

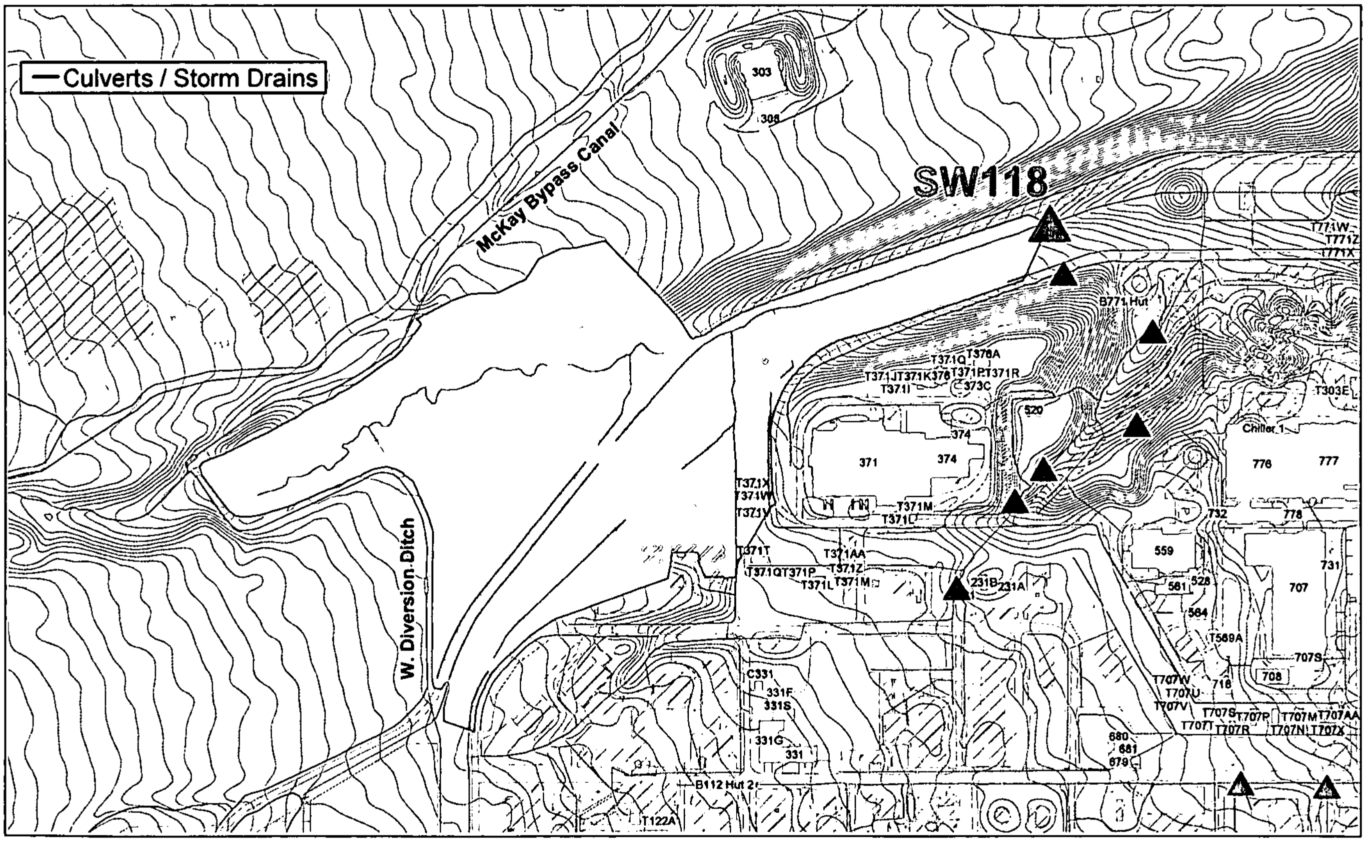


Figure 3-128. Map Showing SW118 Drainage Area.

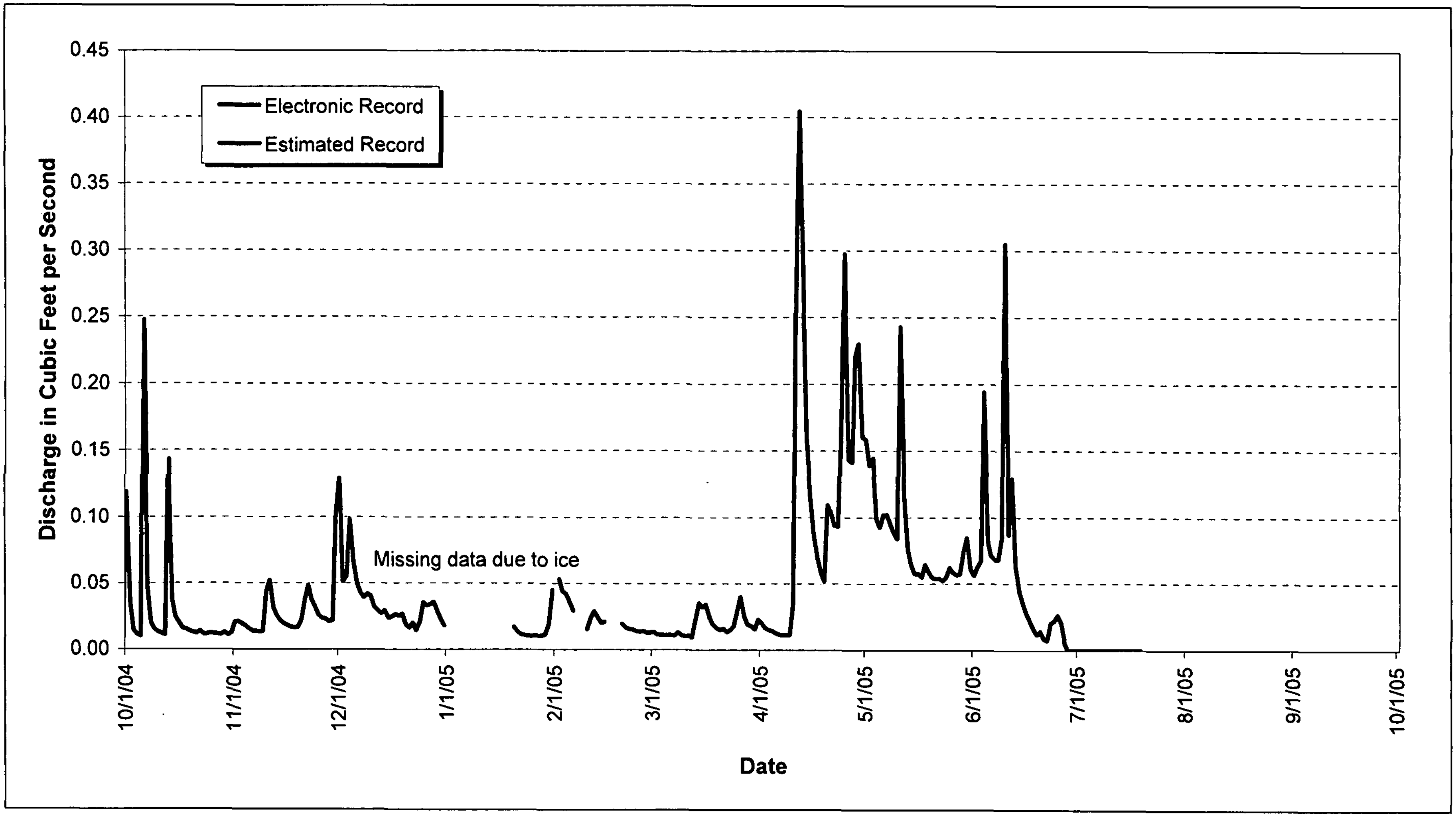


Figure 3-129. WY05 Mean Daily Hydrograph at SW118: North Walnut Creek Upstream of Portal 3.

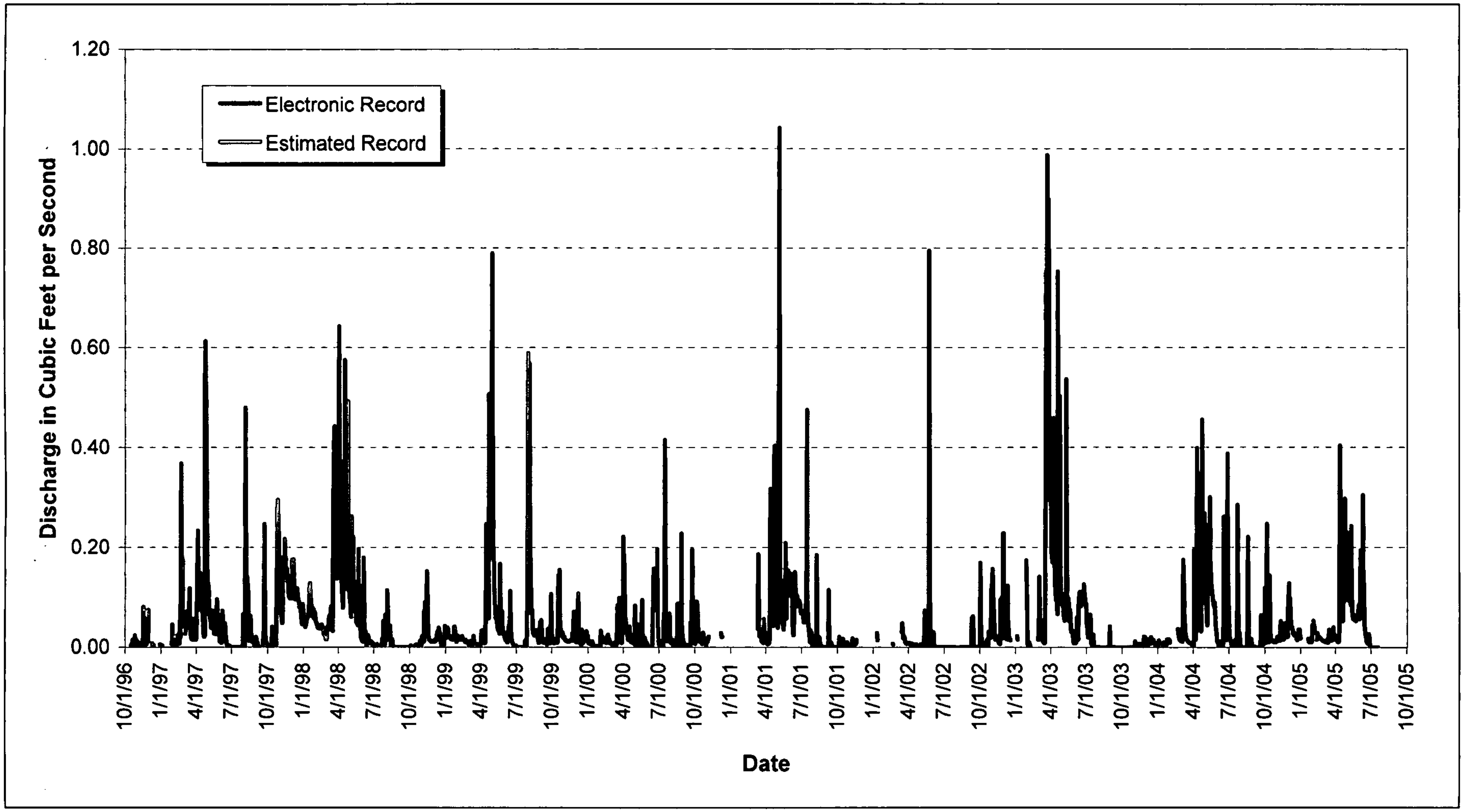


Figure 3-130. WY97-05 Mean Daily Hydrograph at SW118: North Walnut Creek Upstream of Portal 3.

3.2.44 SW119: Ditch along PA Perimeter Road North of Solar Pond 207B

Location

Ditch along Protected Area (PA) Perimeter Road north of Solar Pond 207B; State Plane: E2084723, N751268

Drainage Area

- The basin includes areas north and east of the Solar Ponds (total of 9.5 acres)
- IA Areas draining to SW119: 900

Period of Record

4/4/01 to 3/1/05 (removed from service)

Gage

Water-stage recorder and 9" Parshall flume

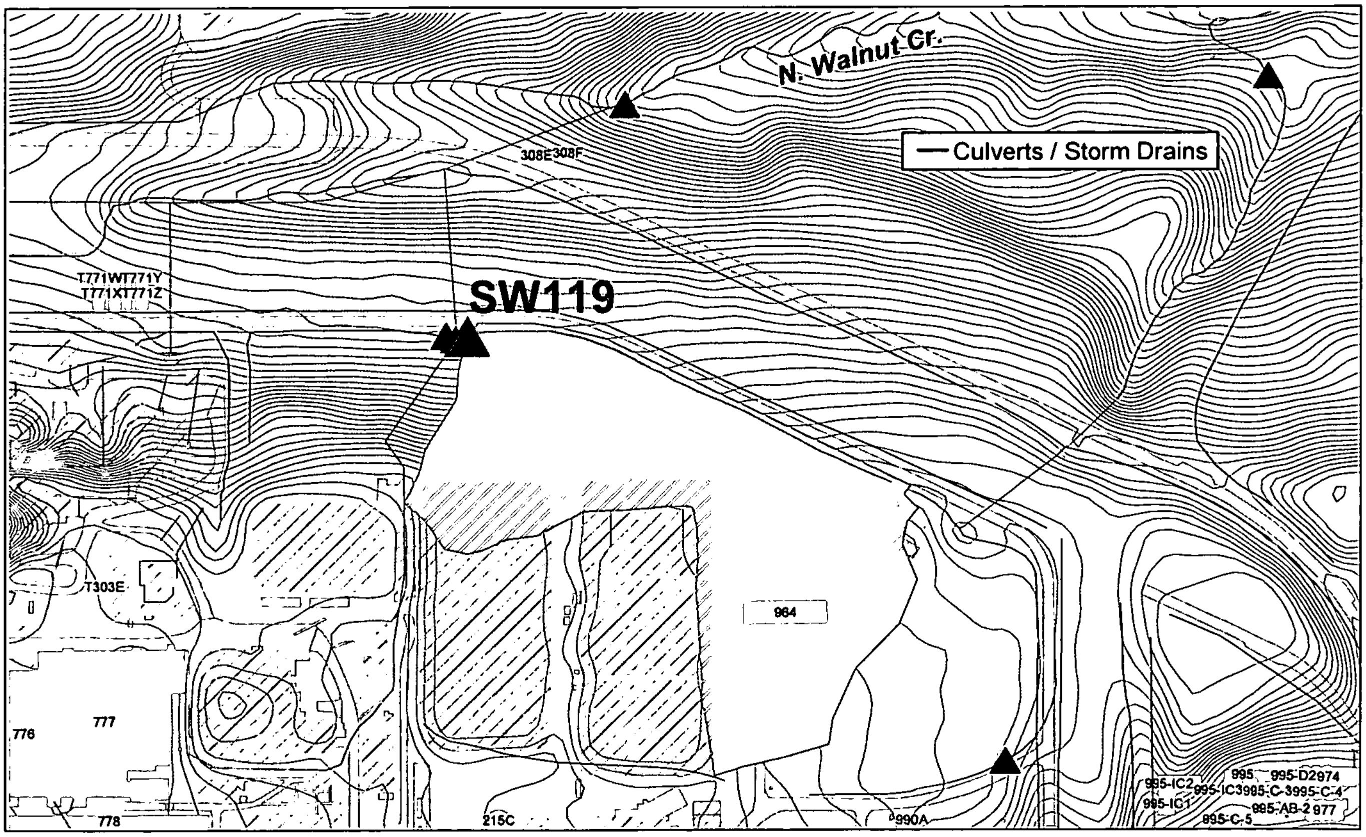


Figure 3-131. Map Showing SW119 Drainage Area.

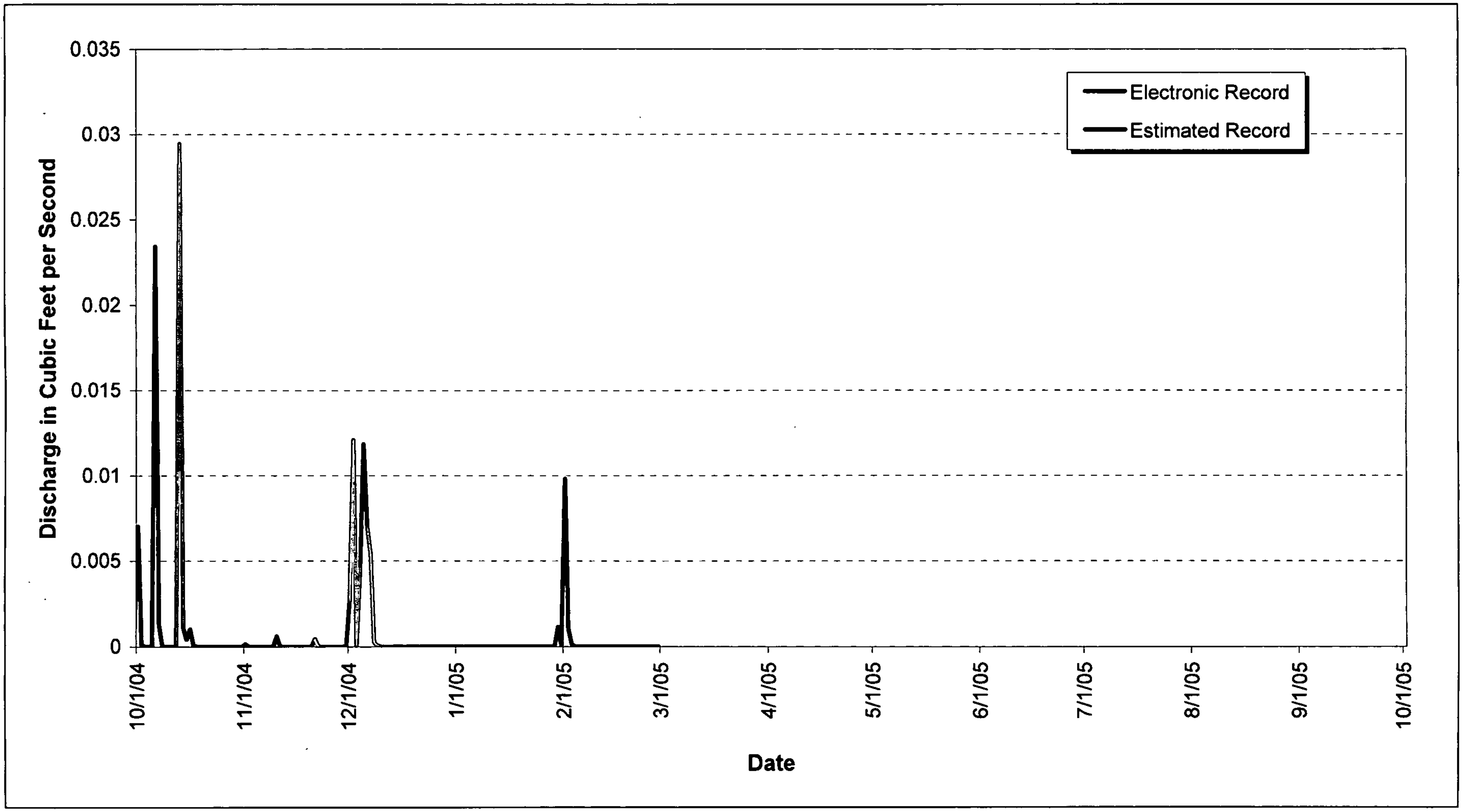


Figure 3-132. WY05 Mean Daily Hydrograph at SW119: Ditch along PA Perimeter Road North of Solar Pond 207B.

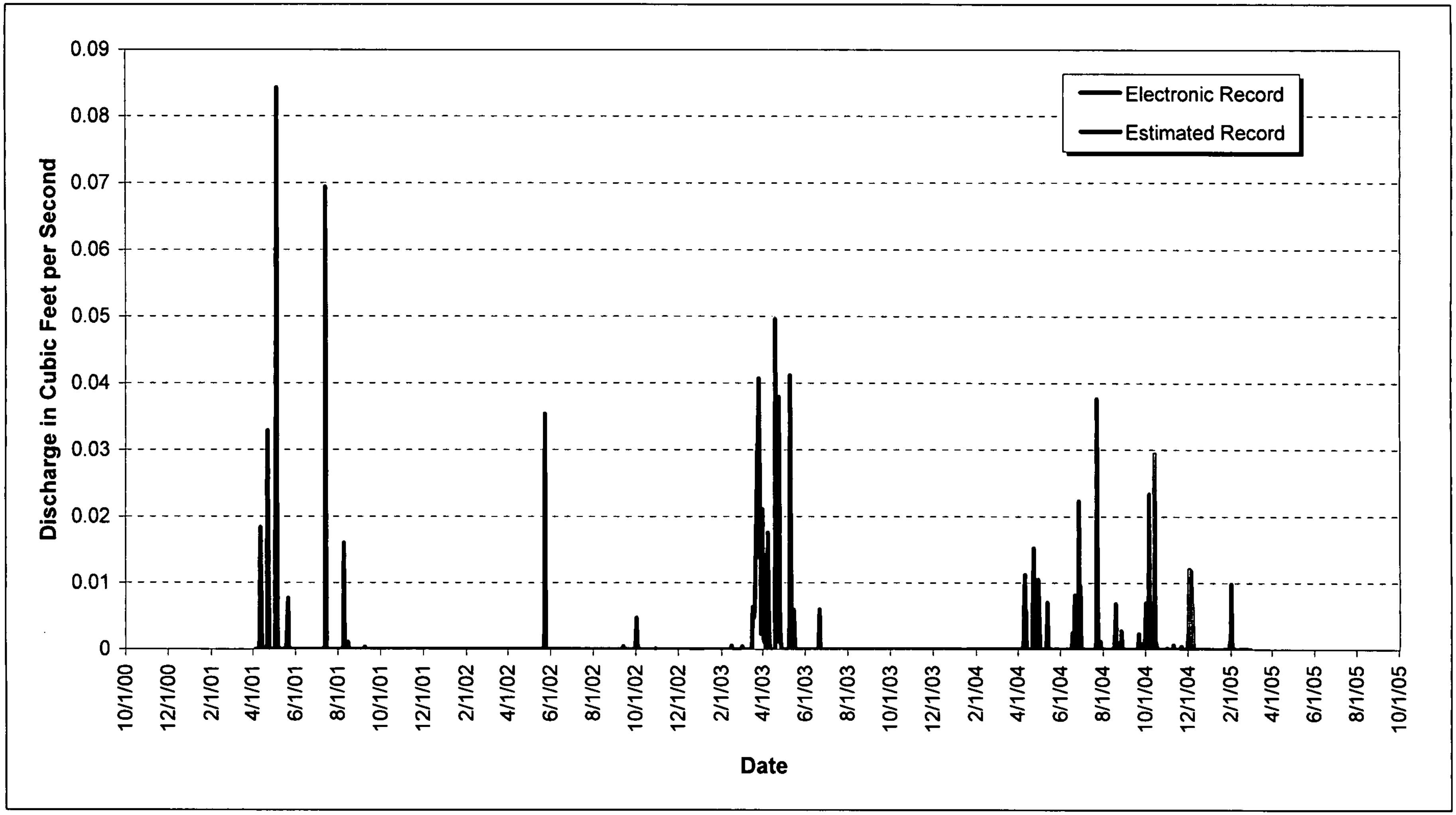


Figure 3-133. WY01-05 Mean Daily Hydrograph at SW119: Ditch along PA Perimeter Road North of Solar Pond 207B.

3.2.45 SW120: Ditch along PA Perimeter Road North of Solar Pond 207A

Location

Ditch along PA Perimeter Road draining 771/774 area; State Plane: E2084682, N751269

Drainage Area

- The basin includes the northeast potion of the B771/774 subdrainage (total of 12.9 acres)
- IA Areas draining to SW120: 700

Period of Record

3/14/00 to 3/15/05 (removed from service)

Gage

Water-stage recorder and 4" cutthroat flume

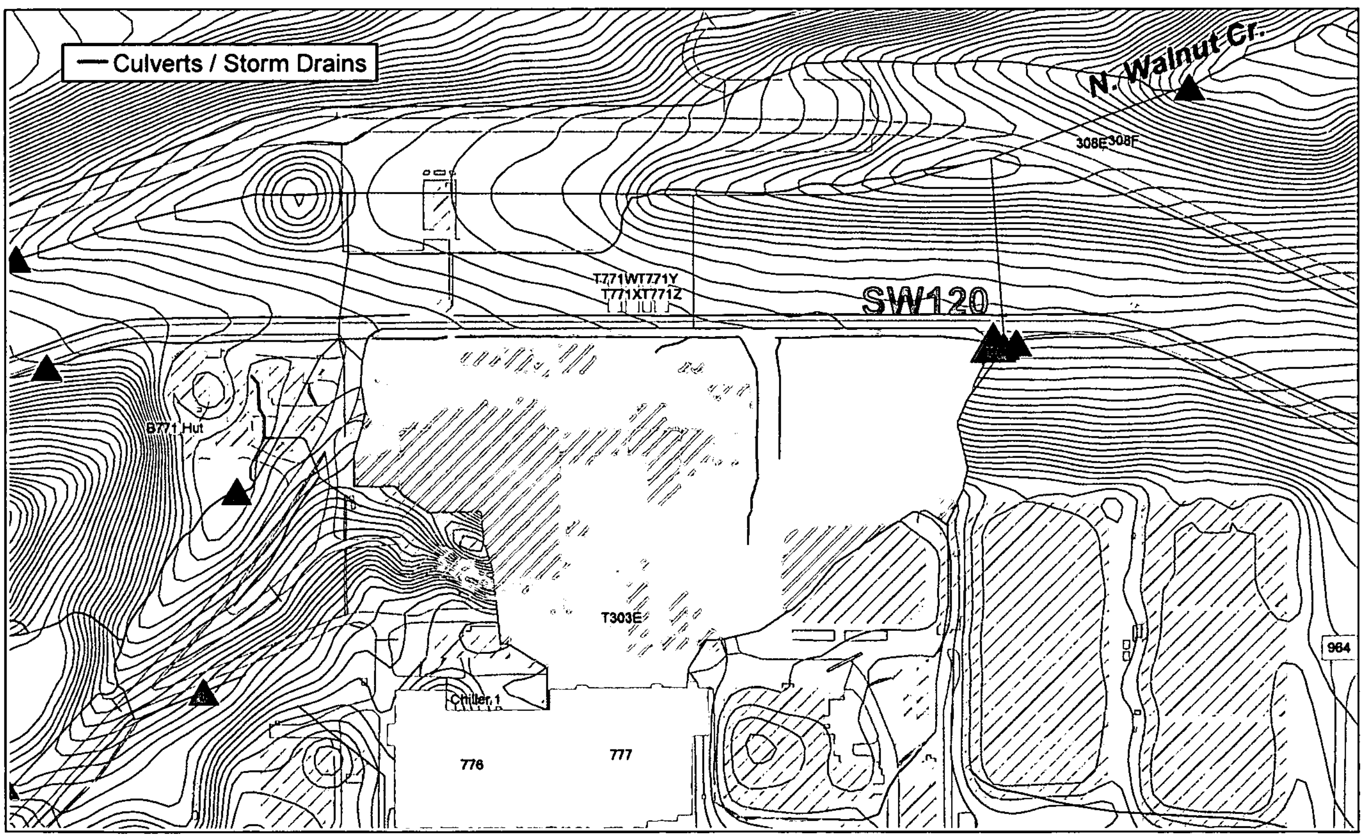


Figure 3-134. Map Showing SW120 Drainage Area.

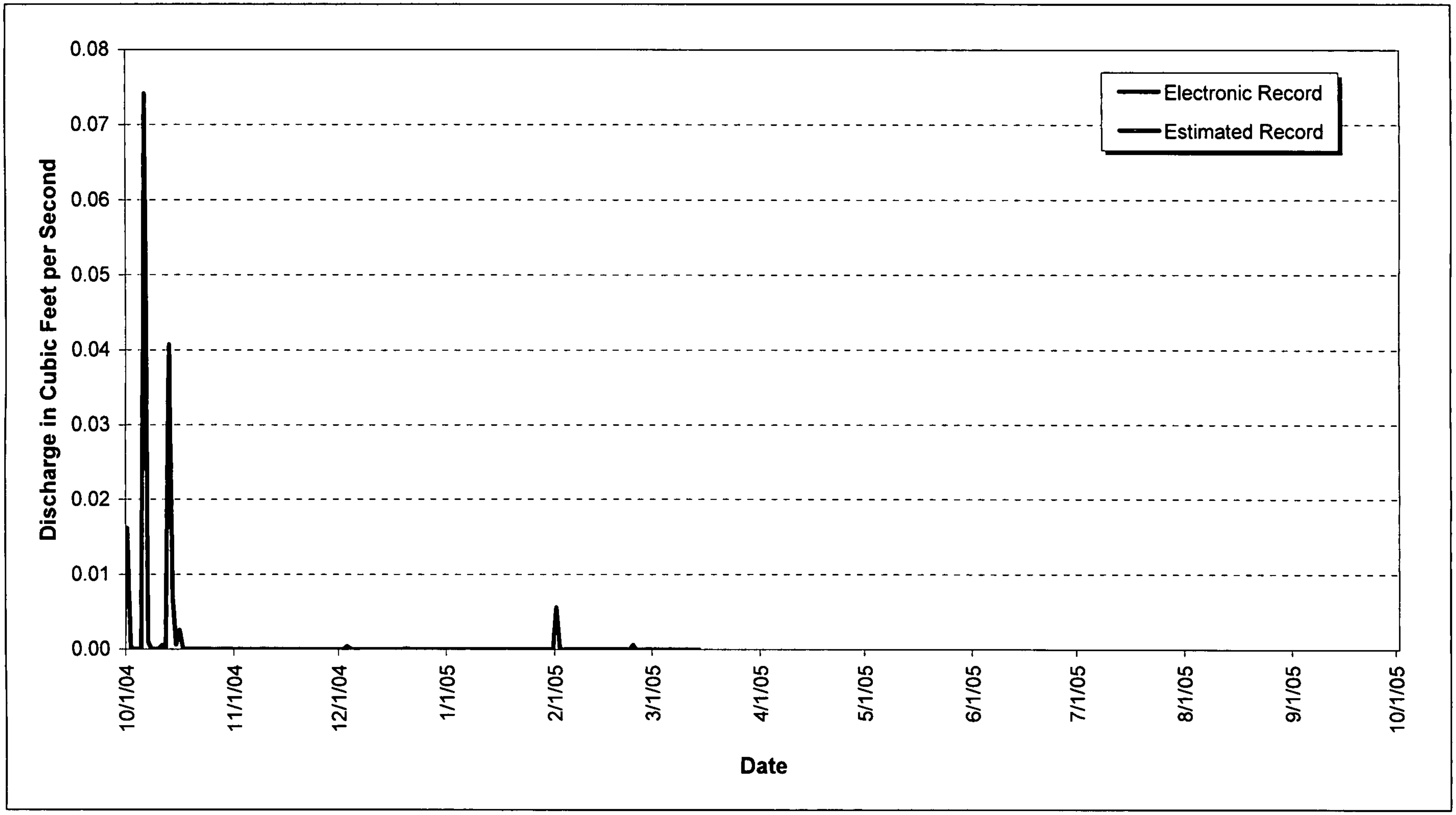


Figure 3-135. WY05 Mean Daily Hydrograph at SW120: PA Perimeter Road Ditch North of Solar Pond 207A.

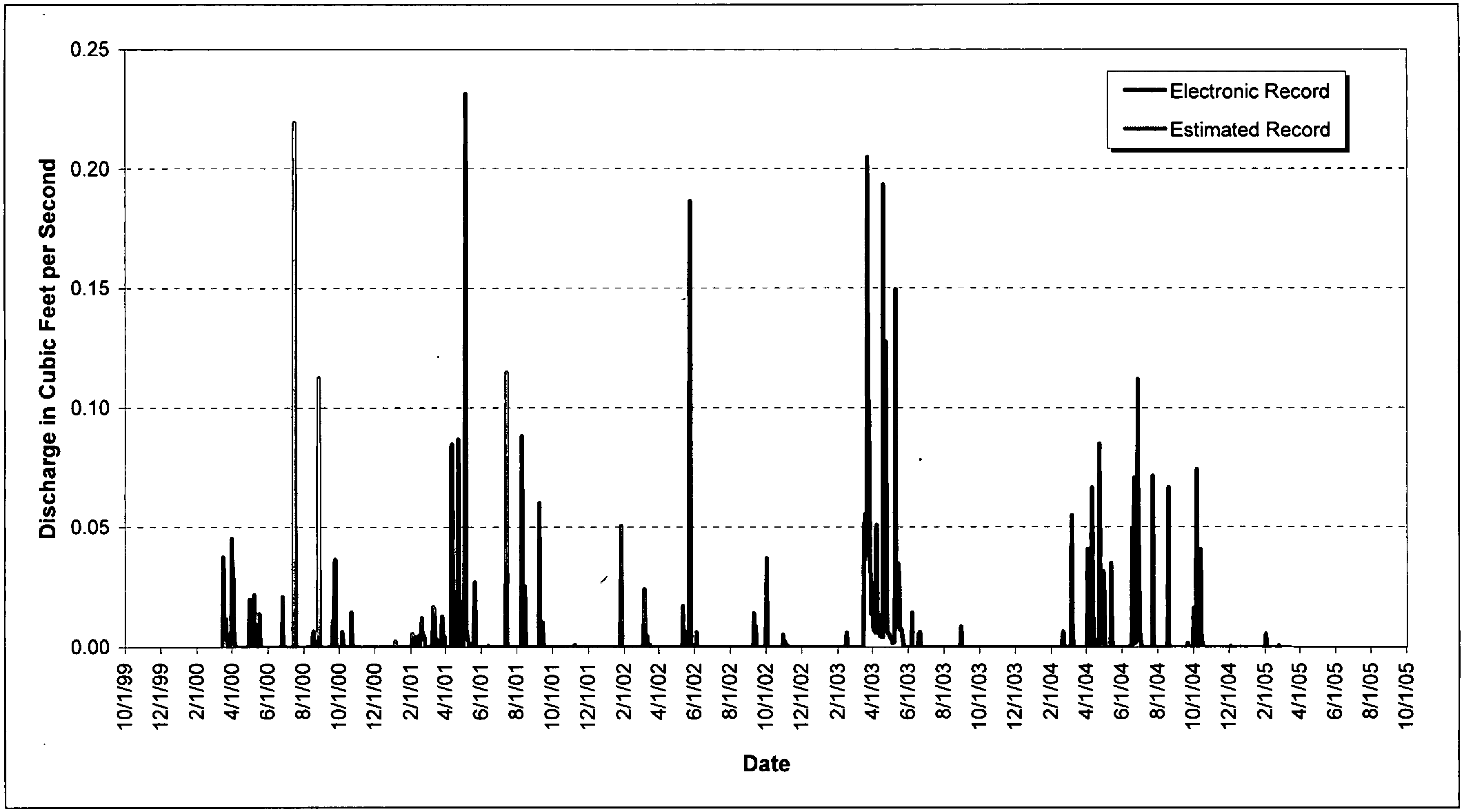


Figure 3-136. WY00-05 Mean Daily Hydrograph at SW120: PA Perimeter Road Ditch North of Solar Pond 207A.

3.2.46 SW134: Rock Creek Tributary at Gravel Pits Northeast of West Gate

Location

Pump discharge outfall for gravel pits northeast of West Gate; State Plane: E2075942, N750049

Drainage Area

- The basin includes the gravel pit areas that are pump discharged to Rock Creek
- IA Areas draining to SW134: none

Period of Record

5/4/94 to 9/13/05 (removed from service)

Gage

Water-stage recorder and 6" Parshall flume with weir insert

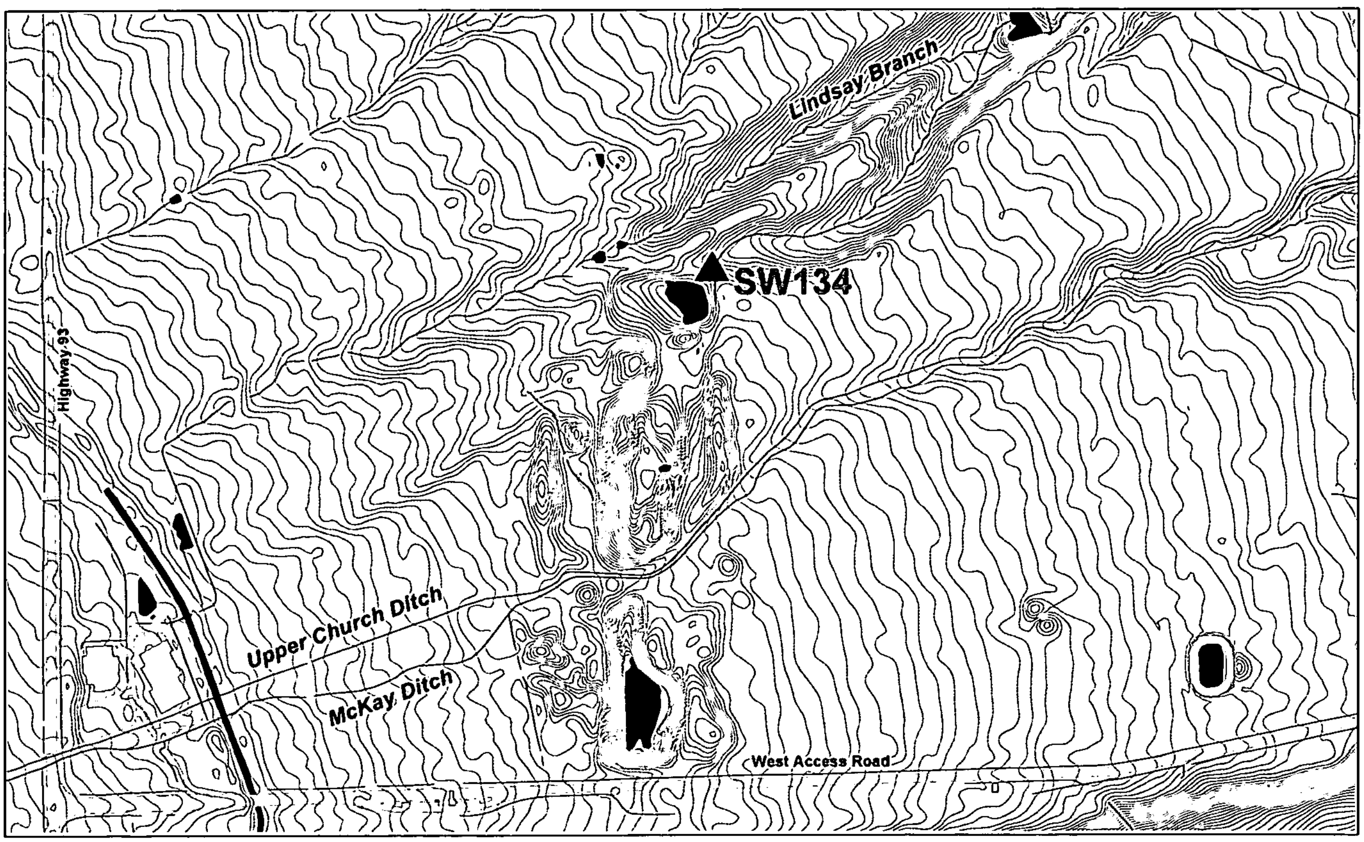


Figure 3-137. Map Showing SW134 Location.

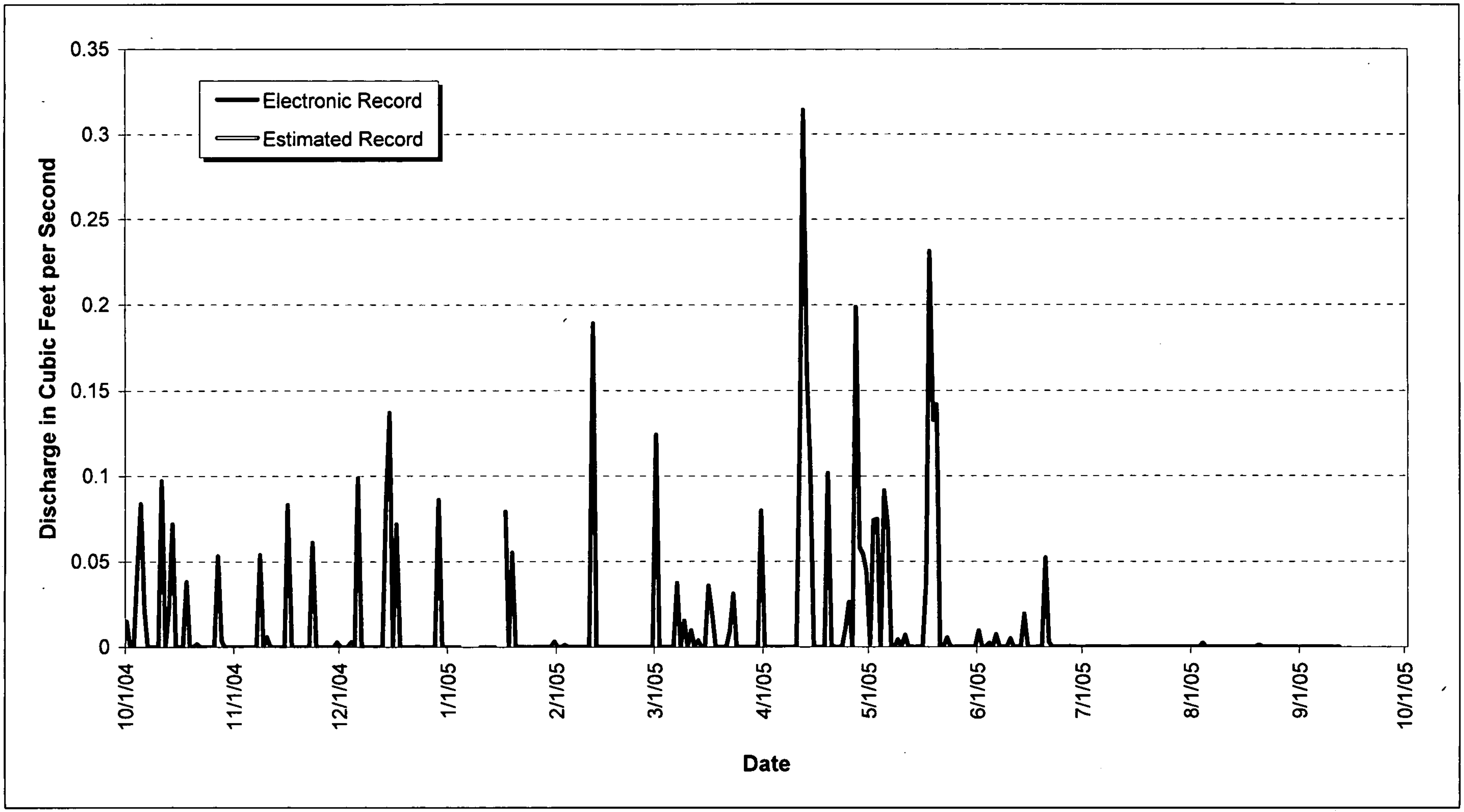


Figure 3-138. WY05 Mean Daily Hydrograph at SW134: Rock Creek Tributary at Gravel Pits Northeast of West Gate.

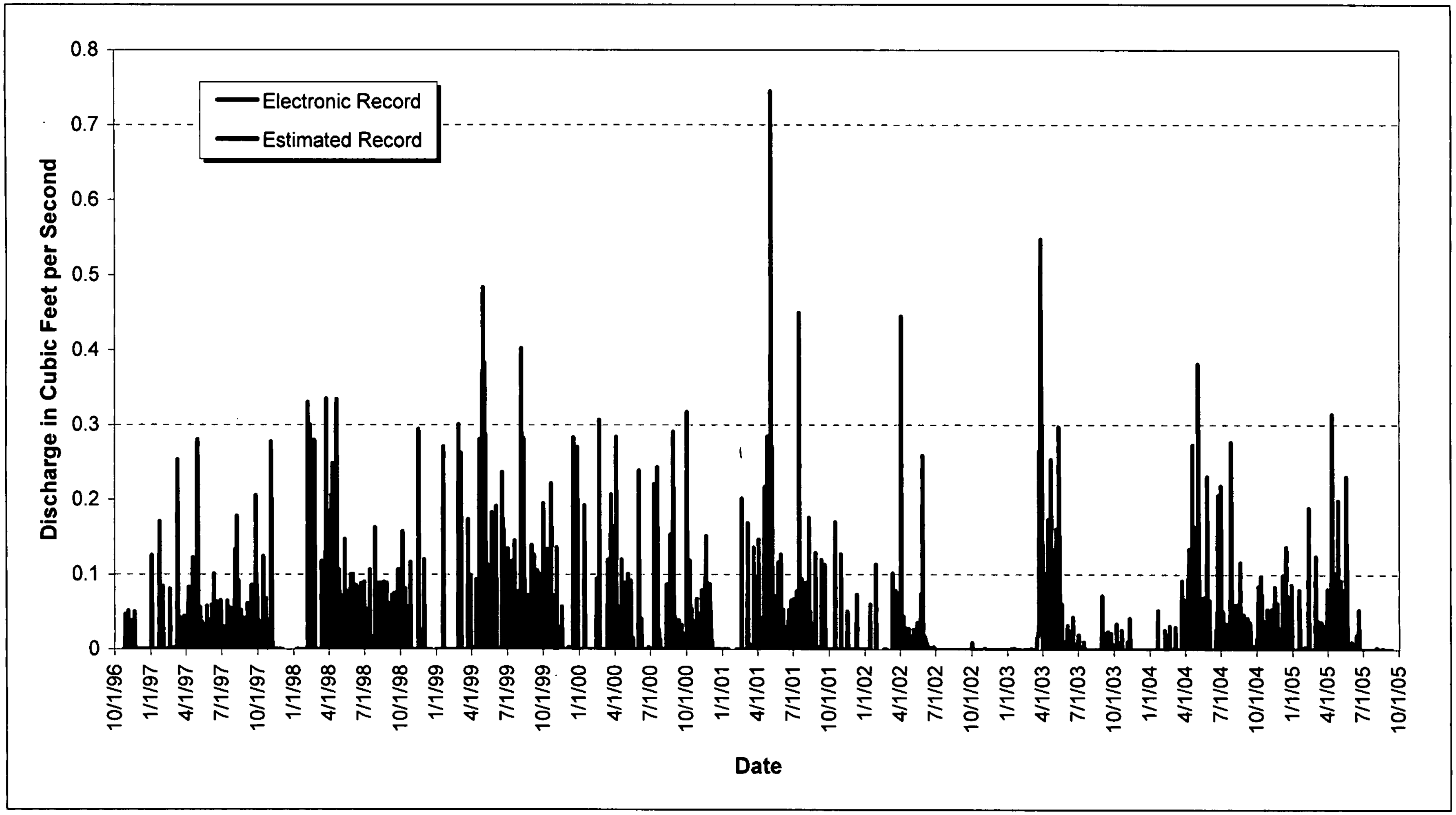


Figure 3-139. WY97-05 Mean Daily Hydrograph at SW134: Rock Creek Tributary at Gravel Pits Northeast of West Gate.

3.2.47 B371Bas and B371Subbas: B371 Basement and Subbasement Footing Drain Outfalls

Location

B371 footing drain outfalls to a ditch tributary to North Walnut Creek

B371Bas; State Plane: E2082831, N750362

B371Subbas; State Plane: E2082939, N750485

Drainage Area

- NA

Period of Record

WY98 to 5/26/05 (removed from service)

Gage

11.4° V-Notch Weirs

Flow data are not given in this report. Data can be found as reported in Appendix 1 of the *Building 371 Subsurface Drain System* procedure (4-K14-SDS-371).

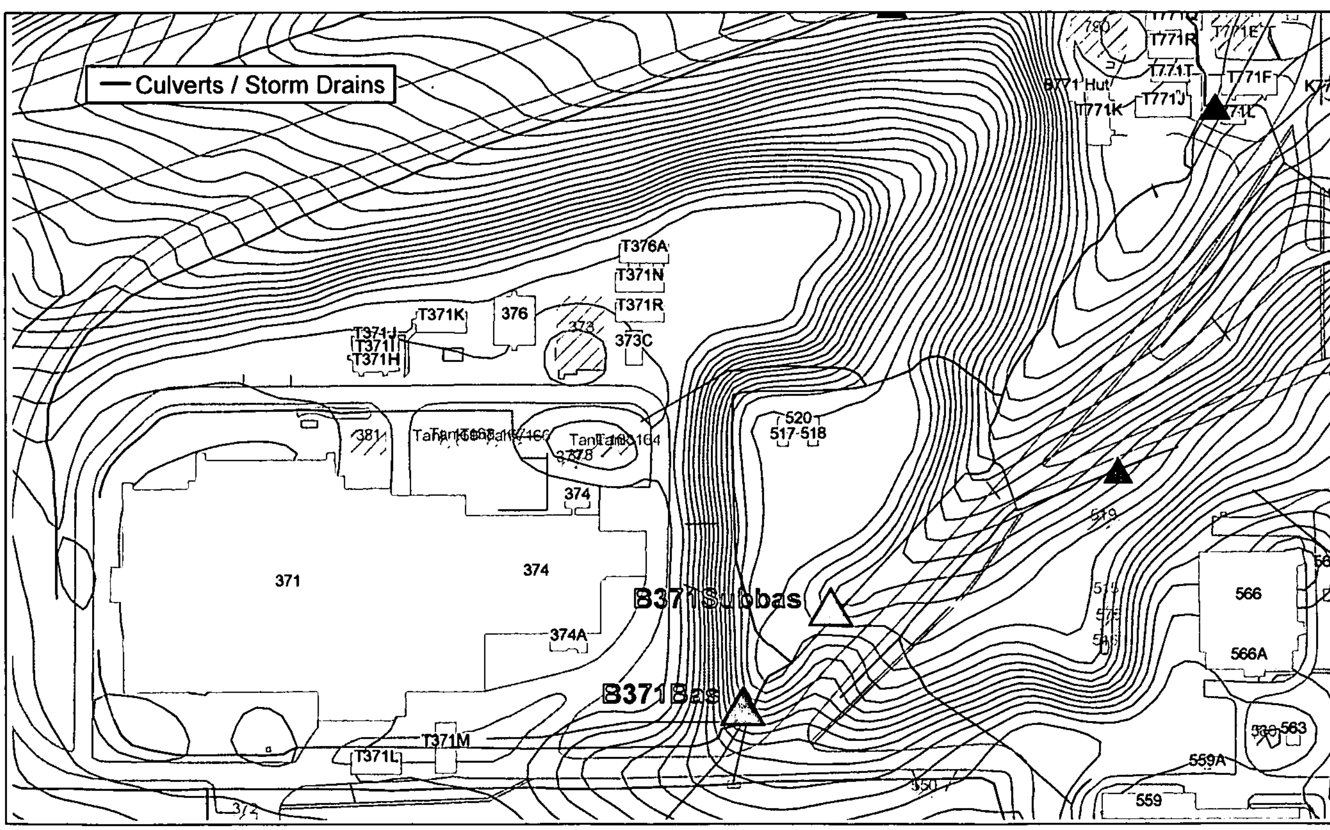


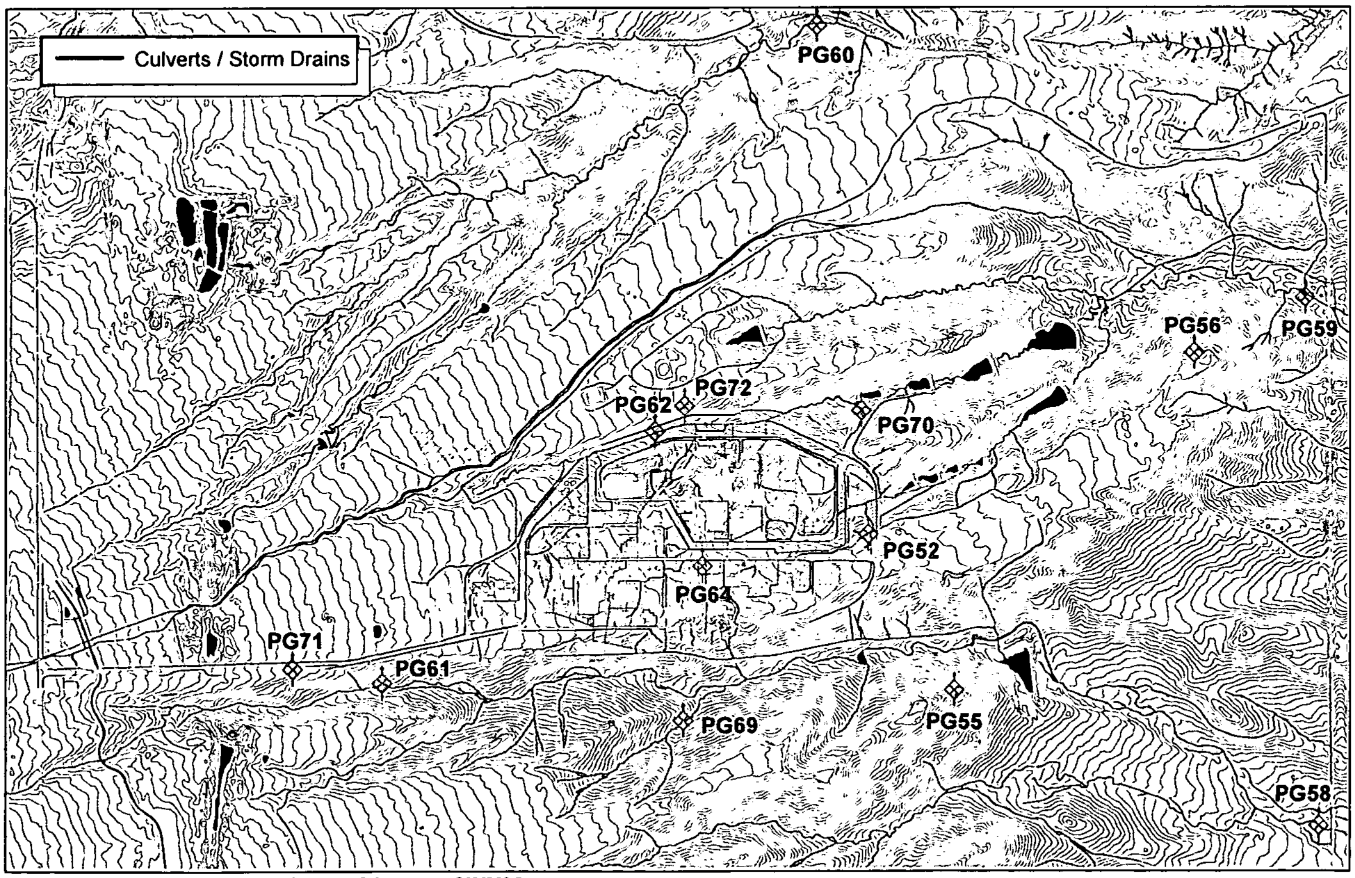
Figure 3-140. Map Showing B371 Basement and Subbasement Footing Drain Outfall Locations.

3.3 PRECIPITATION DATA

During WY05, 13 precipitation gages were operated as part of the automated surface-water monitoring network. The locations employ tipping-bucket rain gages generally mounted at ground level. Precipitation totals are logged on 5- and/or 15-minute intervals. The gages are not heated and may not accurately record equivalent precipitation in snowfall. The following sections present several figures summarizing the precipitation data collected for WY97-2005.

Table 3-1. Monitoring Network Precipitation Gage Information.

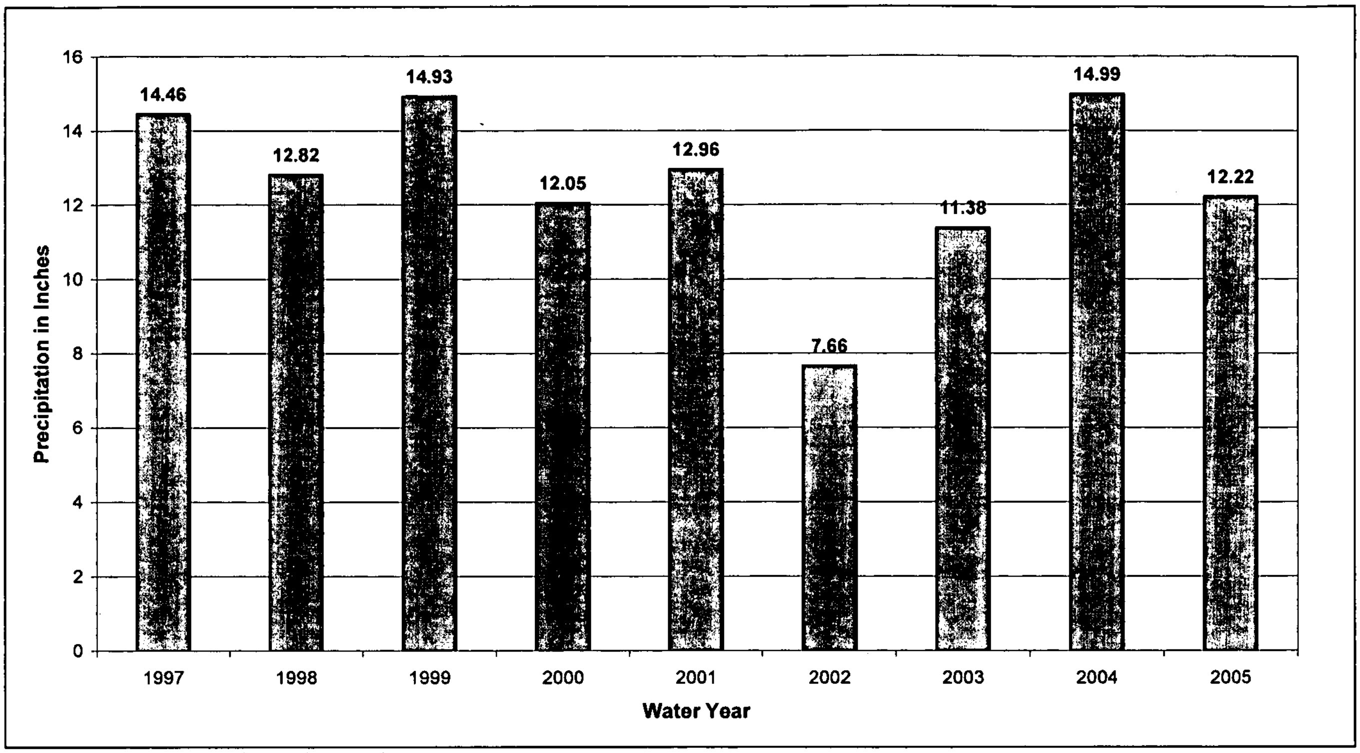
Location Code [Surface-Water Gage]	Easting [State Plane]	Northing [State Plane]	Period of Operation
PG52 [SW022]	2086407	749734	<10/1/92 – 4/17/05
PG55 [NA]	2087896	747239	7/19/94 – current year
PG56 [NA]	2091513	752593	7/18/94 – current year
PG58 [GS01]	2093820	744893	10/11/96 – current year
PG59 [GS03]	2093611	753649	4/1/96 – current year
PG60 [GS04]	2085544	758125	4/1/96 – current year
PG61 [GS05]	2078428	747260	4/1/96 – 9/30/05
PG62 [SW118]	2082961	751417	10/29/96 – 7/21/05
PG64 [GS38]	2083689	749208	2/15/00 – 6/5/05
PG69 [GS16]	2086290	751773	3/27/02 – 9/30/05
PG70 [SW091]	2083373	746665	3/29/02 – 9/7/05
PG71 [NA]	2076968	747517	3/31/04 – 6/1/05
PG72 [NA]	2083394	751852	6/7/05 – current year



Note: Map shows Site configuration as of the start of WY05.

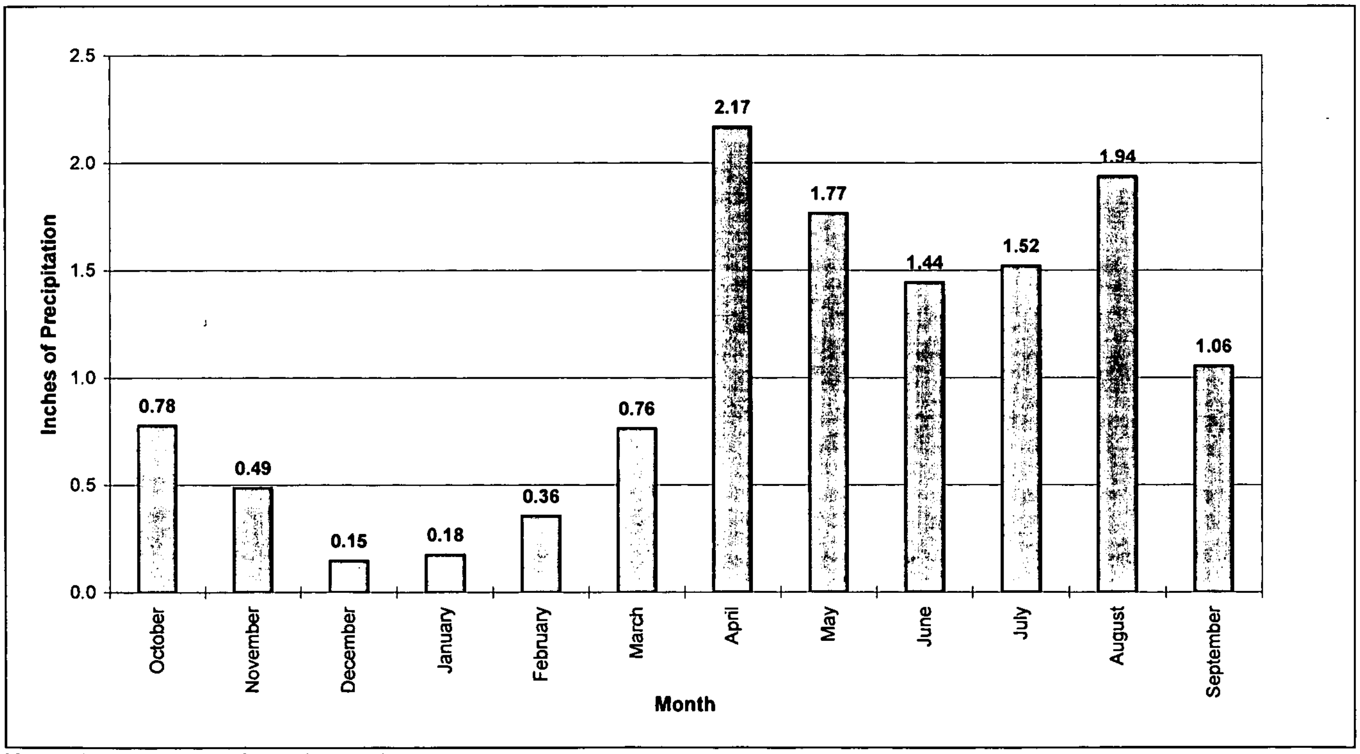
Figure 3-141. Map of Automated Surface-Water Monitoring Precipitation Gages: WY05.

3.3.1 WY97–05 Summary



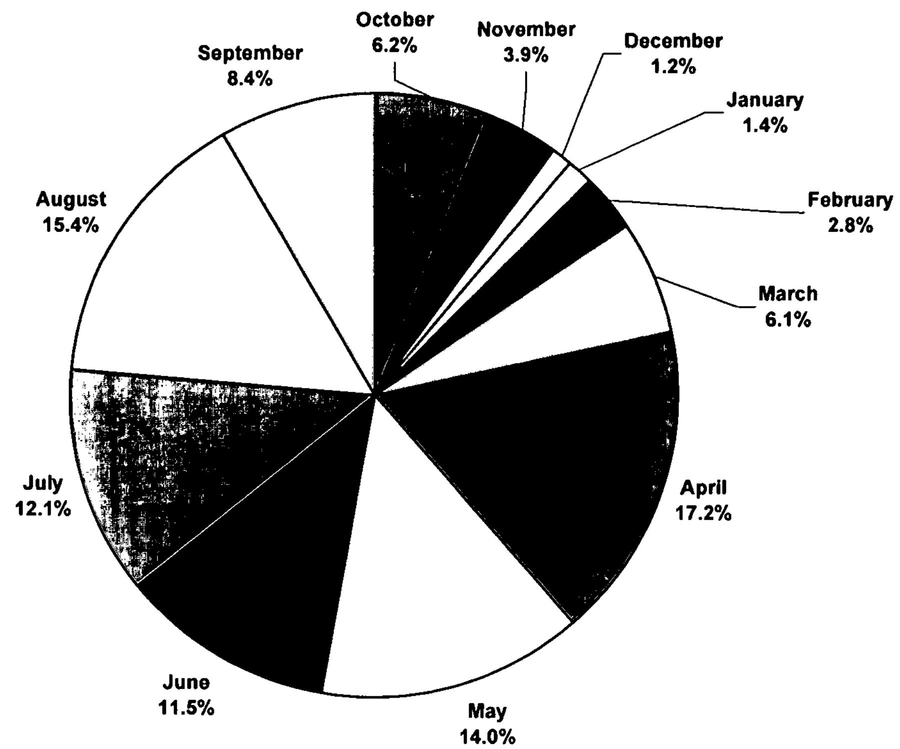
Note: Arithmetic average of gages in operation.

Figure 3-142. Annual Total Precipitation for WY97–05.



Note: Arithmetic average of gages in operation.

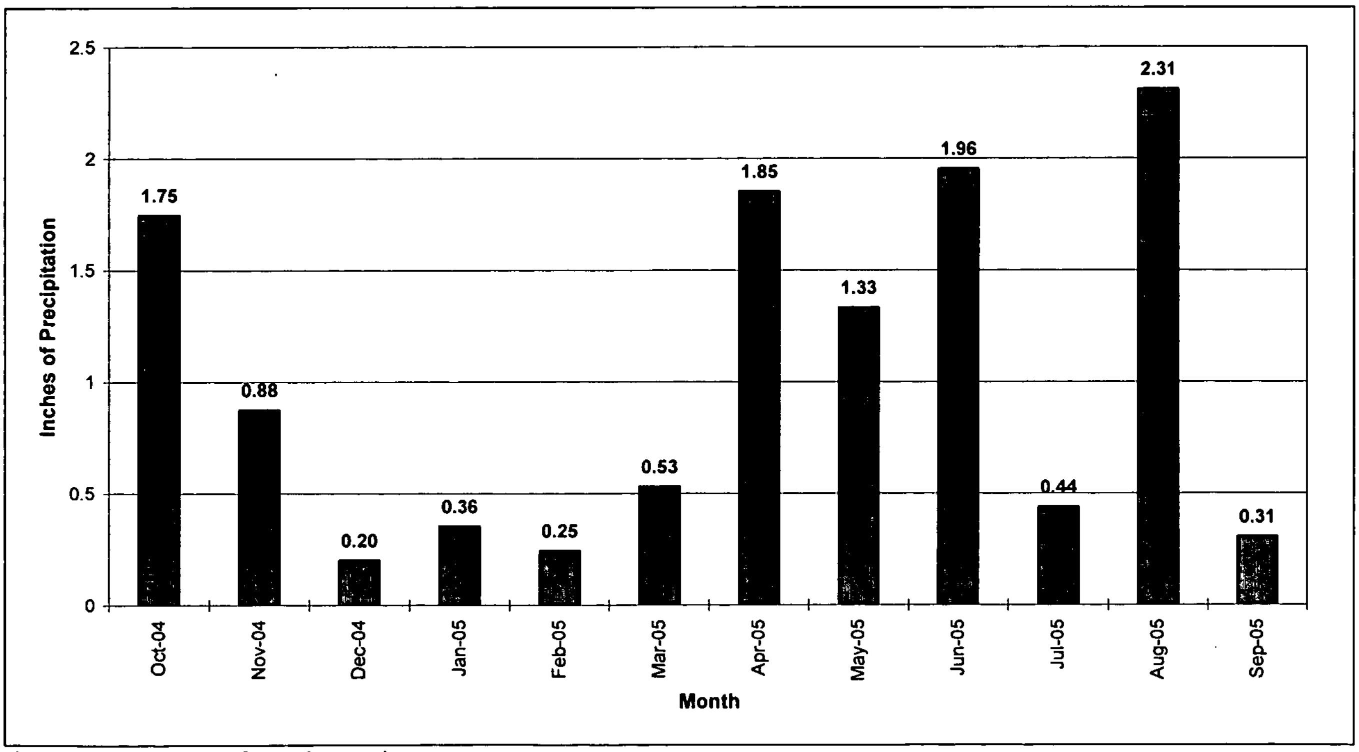
Figure 3-143. Average Monthly Precipitation for WY97–05.



Note: Arithmetic average of gages in operation.

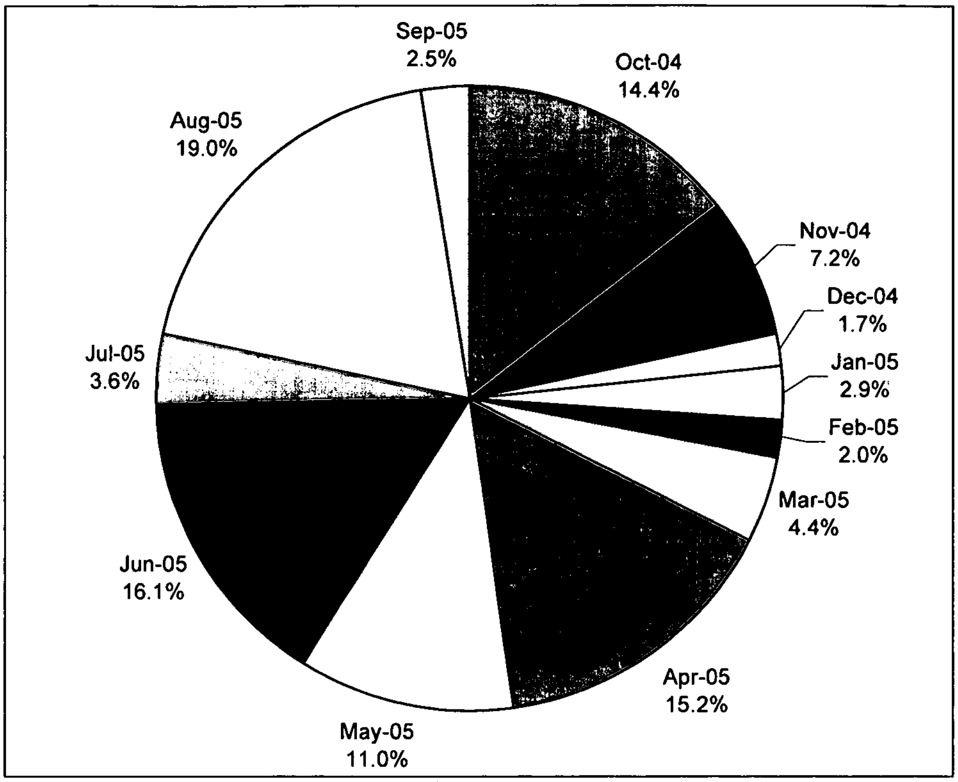
Figure 3-144. Relative Monthly Precipitation Totals for WY97–05.

3.3.2 WY05



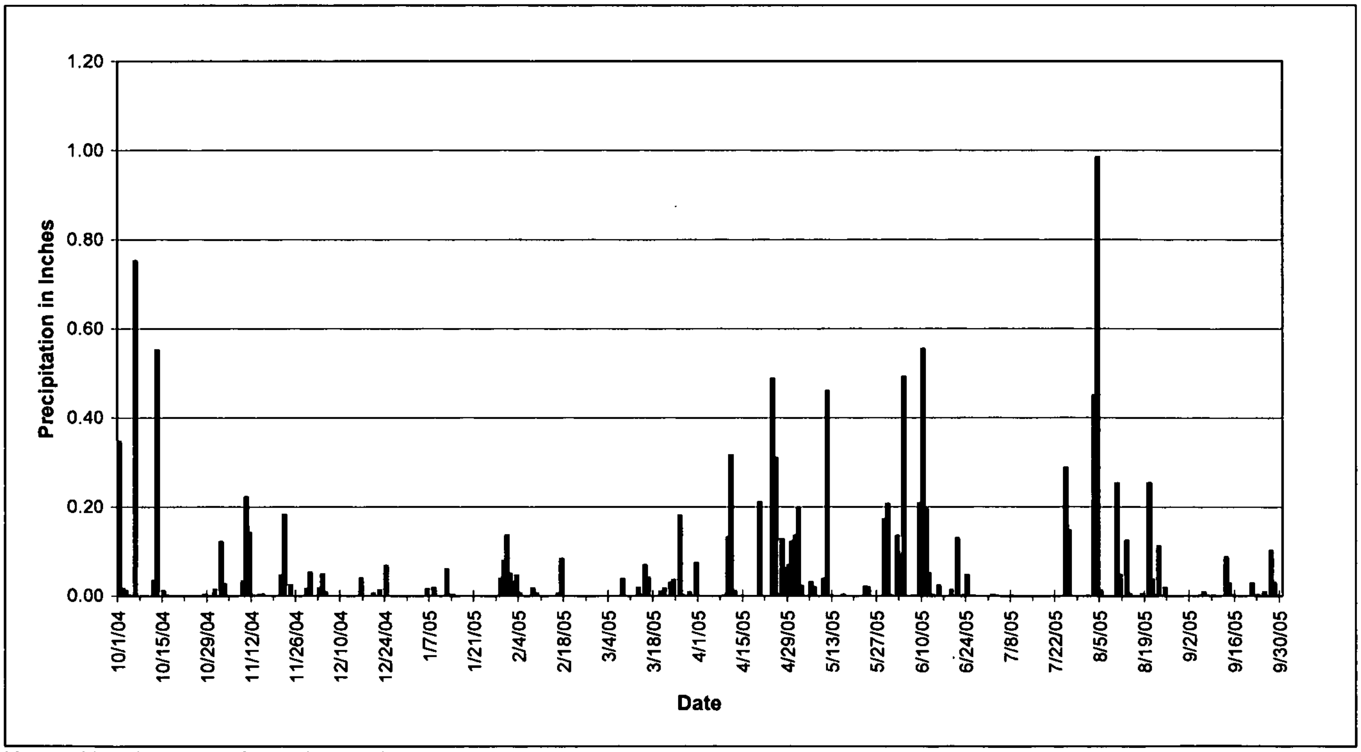
Note: Arithmetic average of gages in operation.

Figure 3-145. Average Monthly Precipitation for WY05.



Note: Arithmetic average of gages in operation.

Figure 3-146. Relative Monthly Precipitation Volumes for WY05.



Note: Arithmetic average of gages in operation.

Figure 3-147. Daily Precipitation Totals for WY05.

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4. WATER-QUALITY SUMMARIES

This section presents water-quality summaries for selected analytes for the period 10/1/96 through 9/30/05 (WY97–05) for the locations operational in WY05. Radionuclides summarized in Section 4.1 include plutonium (Pu), americium (Am)[11], and total uranium. Additionally, the POE metals (total beryllium [Be], dissolved cadmium [Cd], total chromium [Cr], dissolved silver [Ag]) are summarized in Section 4.2. Many additional analyses are also performed based on the specific monitoring objective. The results and evaluation for these additional analytes are presented in Sections 6 through 14 by monitoring objective.

4.1 RADIONUCLIDES

The following summaries include all results that were not rejected through the validation process. Data are generally presented to decimal places as reported by the laboratories. Accuracy should not be inferred; minimum detectable concentrations/activities and analytical error are often greater than the precision presented. When a negative radionuclide result (e.g. -0.002 pCi/L) is reported by the laboratory due to blank correction, then a value of 0.0 pCi/L is used for calculation purposes. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the 'real' and 'duplicate' values.[12] When a sample has multiple 'real' analyses (e.g., Site requested 'reruns'), the value used in calculations is the arithmetic average of the multiple 'real' analyses.[12] Total uranium is calculated by summing the activities for the analyzed isotopes (U-233,234 + U-235 + U-238).

The Pu/Am ratio is calculated for each sample by dividing the Pu result by the corresponding Am result. Ratios are only calculated for samples where *both* the Pu and Am results are greater than 0.015 pCi/L (generally the minimum detectable activity [MDA] for Pu and Am analyses) to exclude ratios for very low results with high relative error.

The U-233,234/U-238 ratio is calculated for each sample by dividing the U-233,234 result by the corresponding U-238 result. Ratios are only calculated for samples where *both* the U-233,234 and U-238 results are greater than 0.025 pCi/L (generally the MDA for these isotope analyses) to exclude ratios for very low results with high relative error. The U-233,234/U-238 ratios can only be used to qualitatively infer the characteristics of the uranium in Site surface water. Since 1999, RFETS groundwater and surface water samples from select locations have been sent to Los Alamos National Laboratory for high resolution inductively-coupled mass spectrometry (HR ICP/MS) and/or thermal ionization mass spectrometry (TIMS) analyses. These analyses measure mass ratios of four uranium isotopes (masses 234, 235, 236, and 238) and are detailed in the reports titled "Uranium in Surface Soil, Surface Water, and Groundwater at the Rocky Flats Environmental Technology Site, dated June 2004" and in the "Interim Measure/Interim Remedial Action for Groundwater at the Rocky Flats Environmental Technology Site, dated June 21, 2005". Isotopic ratios provide a signature that indicates whether the source of uranium is natural, anthropogenic (man-made), or mixed. The results to date indicate that all the groundwater and surface-water locations at the Site display a predominately natural signature.

Each table includes only those locations where samples were collected that were analyzed for the referenced analyte. Maps are also included showing the spatial variation of the location-specific median value for the referenced parameter. Only locations that had four or more individual results are mapped.[13]

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[11] In this report, 'plutonium' or 'Pu' refers to Pu-239,240 and 'americium' or 'Am' refers to Am-241.

[12] Arithmetic averaging of radionuclide pairs is performed only when the duplicate error ratio (DER) is less than 1.5. If the DER is greater than or equal to 1.5, then the radionuclide results are determined to be non-representative. Theese results are not used for the calculation of summary statistics. A more thorough discussion of data management is given in Appendix B.1: Analytical Data Evaluation Methods.

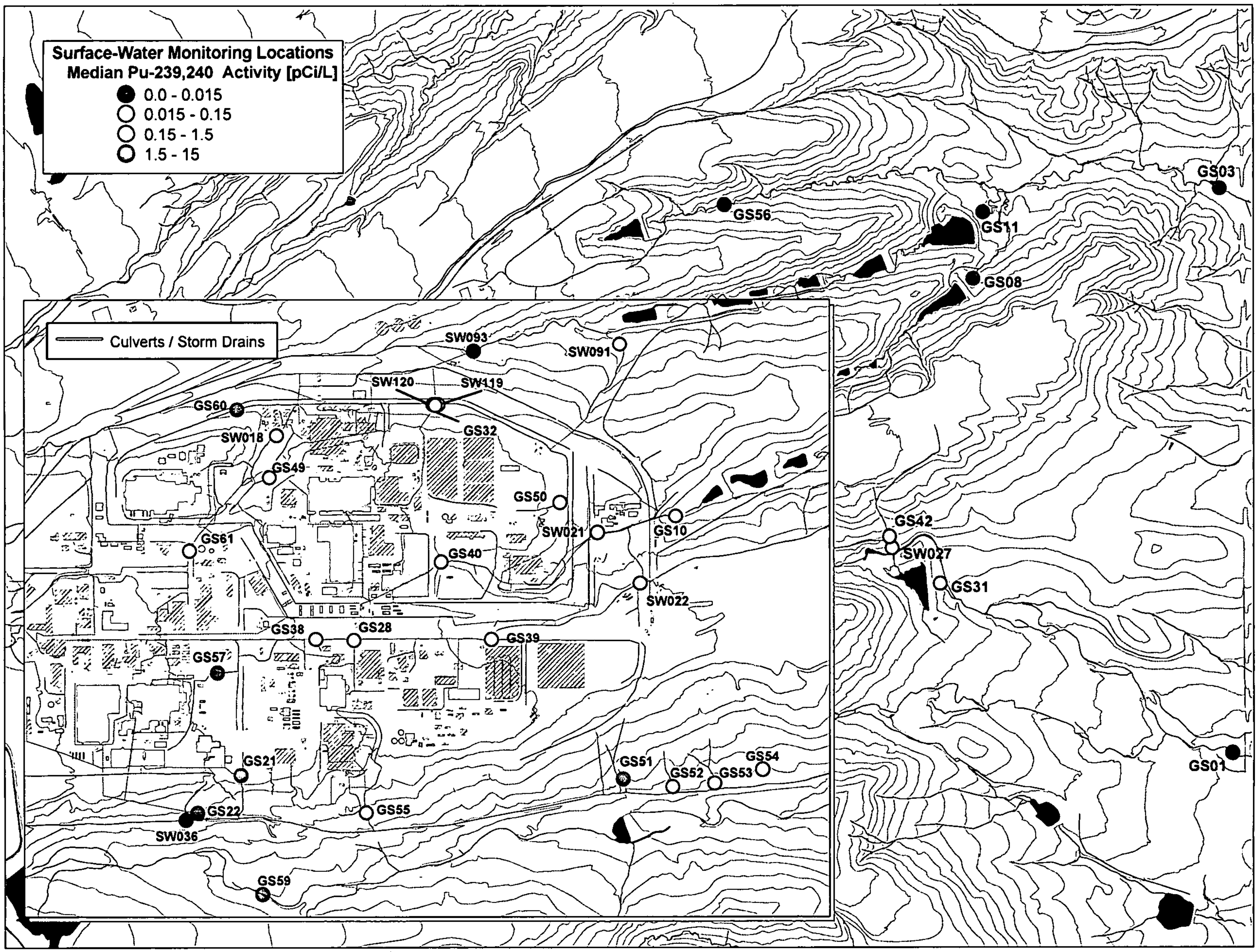
[13] As of the publication of this report, the last samples started in WY05 at GS01, GS03, and SW027 were still in progress. The composite bottles currently contain a non-sufficient quantity (NSQ) for analysis. Therefore, results for these samples are not included.

Table 4-1 and Figure 4-1 show that median Pu activities for the majority of locations outside the IA are below the action level of 0.15 pCi/L[14]. Outside the IA, only GS42, GS51, GS52, GS53, and GS54 had d median activities greater than 0.15 pCi/L. These activities are likely due to the proximity of these monitoring location drainage areas to the 903 Pad. Several locations within the IA showed median Pu activities greater than 0.15 pCi/L.

Table 4-1. Summary Statistics for Pu-239,240 Analytical Results in WY97-05.

Location	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]
GS01	**167**	**0.002**	**0.008**	**0.024**
GS03	**260**	**0.005**	**0.016**	**0.220**
GS08	**118**	**0.004**	**0.013**	**0.864**
GS10	**272**	**0.054**	**0.204**	**2.27**
GS11	**92**	**0.002**	**0.009**	**0.070**
GS21	27	0.015	0.047	1.420
GS22	40	0.011	0.034	0.242
GS28	17	0.036	0.137	0.845
GS31	**26**	**0.017**	**0.094**	**0.348**
GS32	91	0.830	4.95	256
GS38	83	0.103	0.293	10.6
GS39	73	0.121	0.974	7.23
GS40	107	0.027	0.221	2.84
GS42	13	0.943	1.53	40.2
GS49	49	0.031	0.251	0.935
GS50	17	0.197	2.37	7.36
GS51	27	3.97	8.41	99.7
GS52	21	1.29	3.95	119
GS53	7	0.784	6.39	49.0
GS54	7	0.565	1.37	2.50
GS55	47	0.016	0.053	0.568
GS56	23	0.001	0.007	0.056
GS57	55	0.010	0.048	0.236
GS59	30	0.000	0.004	0.020
GS60	26	0.008	0.033	3.94
GS61	25	0.024	0.065	0.266
SW018	33	0.017	0.043	0.197
SW021	21	0.085	0.498	0.872
SW022	89	0.100	0.571	9.49
SW027	**72**	**0.045**	**0.197**	**13.2**
SW036	20	0.002	0.003	0.057
SW091	27	0.051	0.200	0.958
SW093	**292**	**0.011**	**0.073**	**4.18**
SW119	26	0.046	0.107	0.400
SW120	42	0.137	0.391	3.63

[14] The Pu, Am, and total uranium standards / action levels noted in this section apply only to POE (995POE, GS10, SW027, and SW093; Section 11) and POC (GS01, GS03, GS08, GS11, and GS31; Section 12) 30-day averages. Comparisons of standards / action levels to other locations are noted in this section for reference only. POEs and POCs are highlighted in **bold** in the tables.



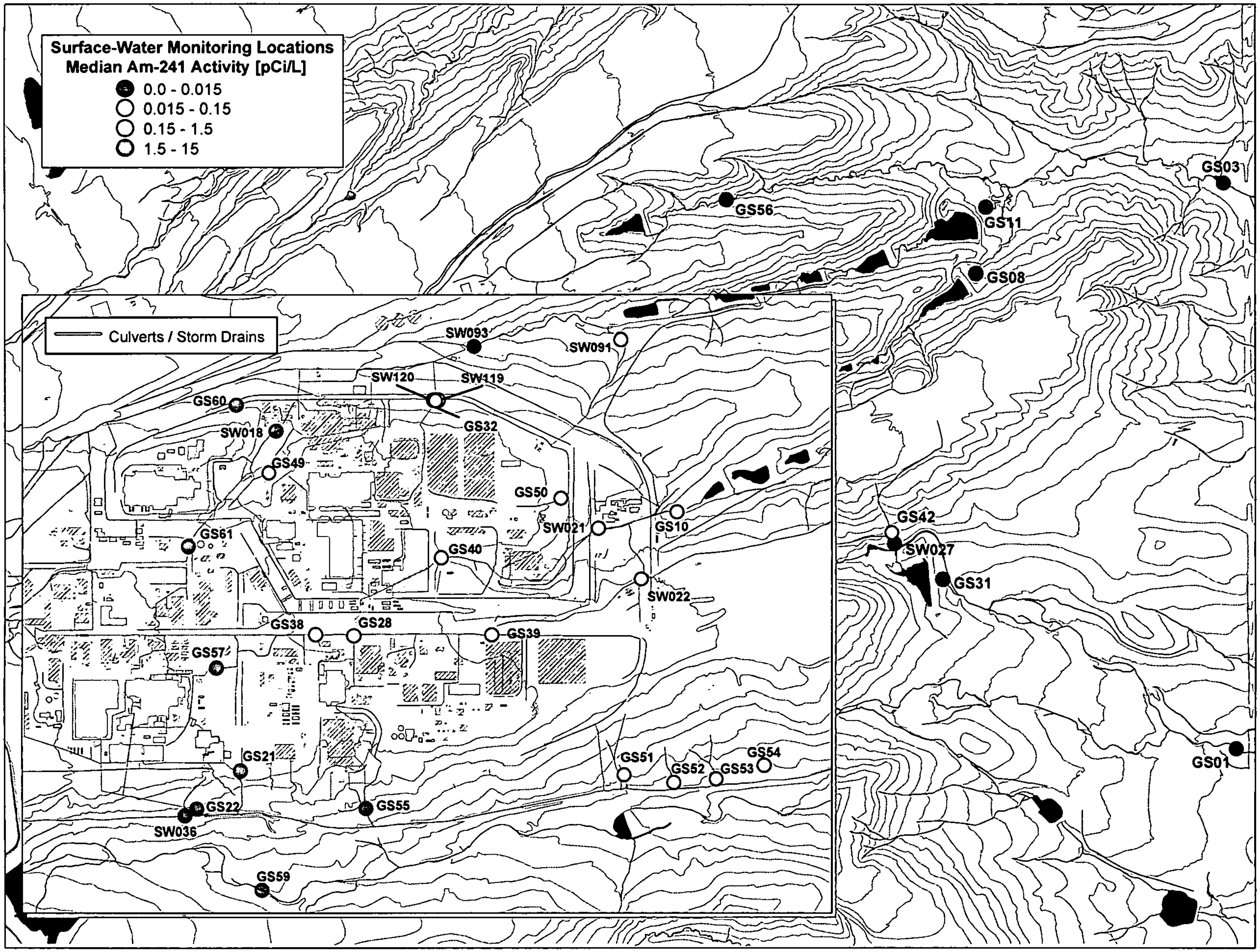
Note: Only locations with four or more results are mapped.

Figure 4-1. Map Showing Median Pu-239,240 Activities for WY97–05.

Table 4-2 and Figure 4-2 show that median Am activities for the majority of locations outside the IA are below the action level of 0.15 pCi/L.[14] Outside the IA, only GS42, GS51, and GS52 had median activities greater than 0.15 pCi/L. These activities are likely due to the proximity of these monitoring location drainage areas to the 903 Pad. Several locations within the IA showed median Am activities greater than 0.15 pCi/L.

Table 4-2. Summary Statistics for Am-241 Analytical Results in WY97-05.

Location	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]
GS01	**166**	**0.001**	**0.008**	**0.054**
GS03	**261**	**0.006**	**0.017**	**0.066**
GS08	**118**	**0.006**	**0.015**	**0.275**
GS10	**265**	**0.057**	**0.185**	**8.39**
GS11	**91**	**0.003**	**0.010**	**0.047**
GS21	26	0.007	0.020	0.242
GS22	39	0.010	0.020	0.109
GS28	17	0.022	0.056	0.166
GS31	**26**	**0.009**	**0.020**	**0.116**
GS32	86	0.563	2.36	13.1
GS38	83	0.029	0.071	0.280
GS39	66	0.038	0.252	1.42
GS40	107	0.047	0.187	2.64
GS42	13	0.169	0.258	6.72
GS49	47	0.025	0.105	0.454
GS50	17	0.442	3.70	12.8
GS51	25	0.807	1.76	3.41
GS52	20	0.154	0.520	1.58
GS53	7	0.124	1.40	11.9
GS54	7	0.084	0.146	0.347
GS55	45	0.005	0.016	0.044
GS56	23	0.002	0.006	0.024
GS57	55	0.006	0.024	7.03
GS59	30	0.001	0.004	0.015
GS60	23	0.007	0.016	1.25
GS61	25	0.008	0.026	0.104
SW018	34	0.008	0.024	0.091
SW021	21	0.143	0.648	0.971
SW022	90	0.031	0.123	1.76
SW027	**72**	**0.009**	**0.044**	**2.33**
SW036	20	0.000	0.002	0.014
SW091	27	0.048	0.241	0.686
SW093	**287**	**0.013**	**0.051**	**14.1**
SW119	25	0.072	0.134	0.384
SW120	41	0.090	0.336	4.49



Note: Only locations with four or more results are mapped.

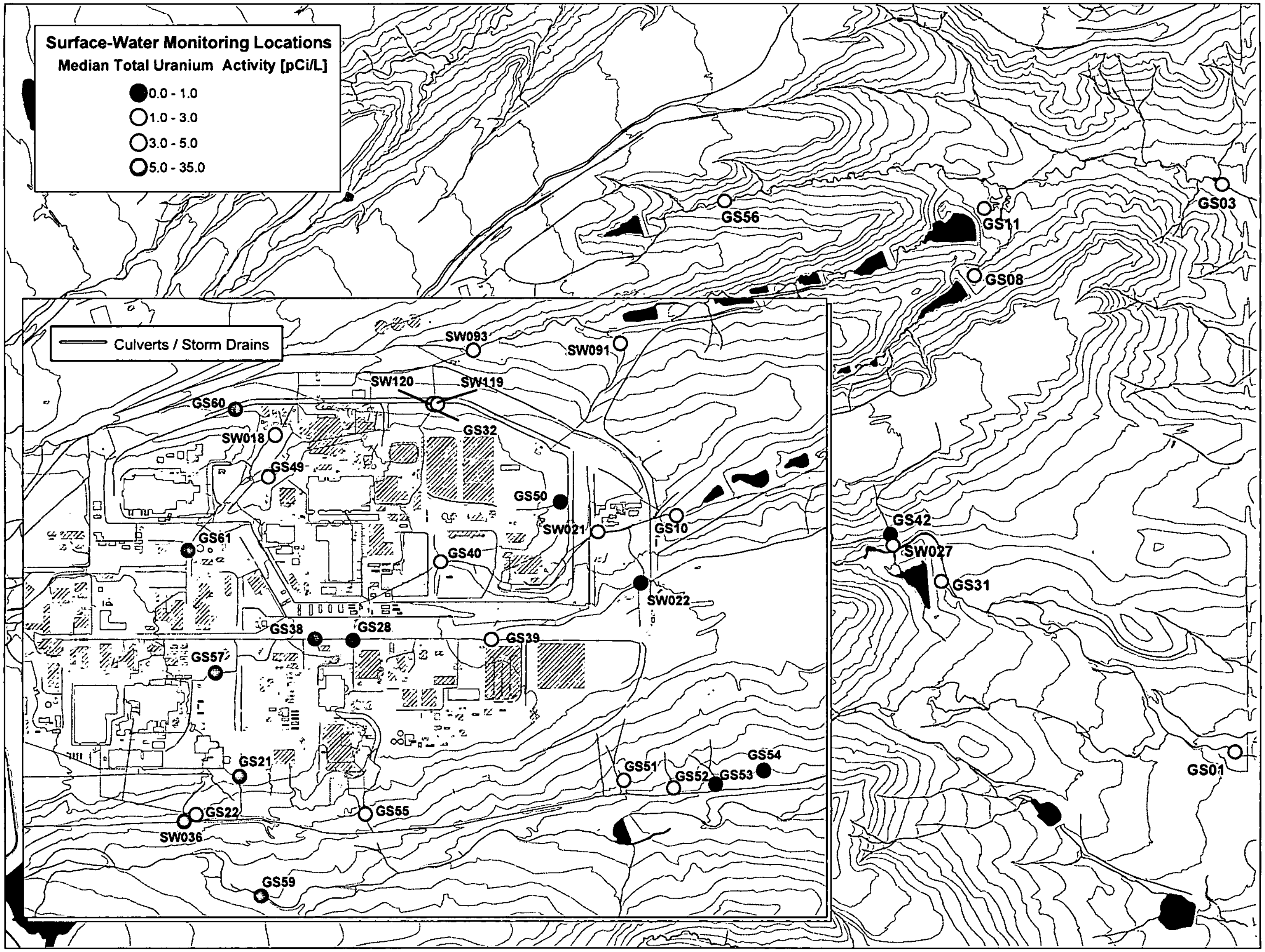
Figure 4-2. Map Showing Median Am-241 Activities for WY97–05.

Table 4-3 and Figure 4-3 show that median total uranium activities for all but one location are below the action level of 10 pCi/L (11 pCi/L for Woman Creek).[14] Location SW036 showed median activities greater than the action level. This activity is likely due to the proximity of SW036 to the Original Landfill. Locations GS10, GS21, GS32, GS40, GS52, GS55, SW021, SW022, SW119, and SW120 showed sample results greater than the action level. The activities at GS32, SW021, SW119, and SW120 are likely due to the proximity to the Solar Ponds. Baseflow for GS55 is sustained by footing drain flows from B881, and baseflow for both GS10 and GS40 is sustained by footing drain and seep flows to S. Walnut Creek. The measurements at these locations are likely due to naturally occurring uranium in groundwater.[15] The results at GS21, GS52, and SW022 appear to be anomalous and no trend is noted.

Table 4-3. Summary Statistics for Total Uranium Analytical Results in WY97-05.

Location	Samples [N]	Median [pCi/L]	85^{th} Percentile [pCi/L]	Maximum [pCi/L]
GS01	**52**	**3.21**	**5.10**	**9.35**
GS03	**77**	**1.77**	**3.25**	**5.43**
GS08	**118**	**1.32**	**2.23**	**6.87**
GS10	**272**	**3.22**	**5.01**	**14.0**
GS11	**92**	**2.08**	**3.08**	**4.06**
GS21	26	0.780	2.58	28.7
GS22	40	1.22	3.17	7.32
GS28	17	0.902	1.78	9.80
GS31	**26**	**2.21**	**2.68**	**4.07**
GS32	91	2.18	7.66	21.2
GS38	43	0.733	2.01	9.94
GS39	35	1.19	3.05	8.14
GS40	80	3.22	4.88	12.4
GS42	11	0.228	0.295	1.05
GS49	49	1.32	4.20	9.59
GS50	17	0.438	2.29	5.59
GS51	26	1.07	1.83	2.76
GS52	20	2.66	8.60	11.5
GS53	7	0.999	1.67	3.67
GS54	7	0.515	4.83	6.82
GS55	47	3.57	5.91	10.5
GS56	23	2.38	4.04	6.88
GS57	55	0.713	2.75	5.01
GS59	30	0.725	1.21	3.87
GS60	26	0.706	1.81	9.54
GS61	25	0.735	2.15	3.62
SW018	33	3.87	5.43	7.94
SW021	21	3.77	6.63	13.2
SW022	90	0.957	2.14	23.4
SW027	**72**	**1.33**	**2.88**	**4.48**
SW036	20	26.0	35.4	39.6
SW091	27	2.95	5.07	7.75
SW093	**291**	**2.76**	**4.22**	**7.33**
SW119	26	2.06	6.17	10.6
SW120	42	3.97	6.86	13.5

[15] The recent uranium measurements at GS10 are discussed in more detail later in this document.



Note: Only locations with four or more results are mapped.

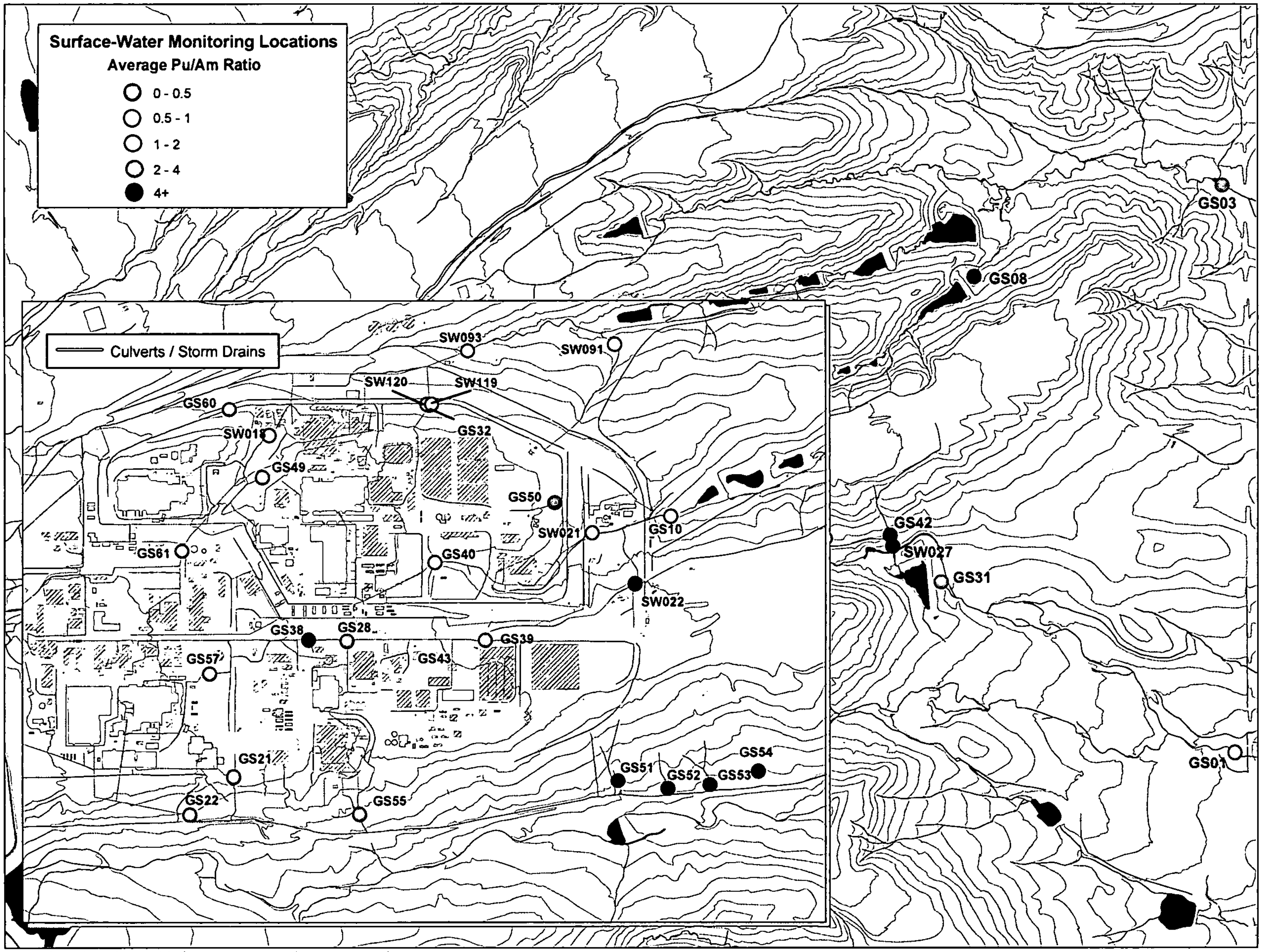
Figure 4-3. Map Showing Median Total Uranium Activities for WY97–05.

Table 4-4 lists the average Pu/Am activity ratios for all locations where samples are analyzed for Pu and Am. A ratio greater than one indicates Pu activity in excess of Am activity. Conversely, a ratio less than one indicates Am activity in excess of Pu activity. Generally, Pu activities are greater than Am activities in surface water at the Site. However, several locations in the IA (GS50, SW021, and SW119) show ratios less than one (Figure 4-4). The significance of these lower ratios has been extensively evaluated in the various Source Evaluation reports for GS10 (see Section 6). The higher ratios at GS31, GS42, GS51, GS52, GS53, and SW027 are likely due to their proximity to the 903 Pad/Lip area. The high ratio at GS08 is due to a few unusual results with higher Pu and very low Am. The higher ratios at GS38 are likely due to contributions from portions of the 400/600 area with low-level soil contamination and similarly high ratios.

Table 4-4. Average Pu/Am Ratios for Analytical Results in WY97-05.

Location	Samples [N][a]	Average Pu/Am Ratio
GS01	**2**	**1.1**
GS03	**14**	**2.1**
GS08	**5**	**8.9**
GS10	**203**	**1.3**
GS11	*	*
GS21	5	3.2
GS22	7	2.2
GS28	9	2.9
GS31	**4**	**3.9**
GS32	85	2.1
GS38	59	5.7
GS39	47	3.3
GS40	65	1.3
GS42	13	6.3
GS49	26	2.3
GS50	17	0.5
GS51	24	4.6
GS52	19	9.5
GS53	7	5.3
GS54	4	8.5
GS55	7	2.2
GS56	1	2.3
GS57	10	2.6
GS59	*	*
GS60	4	2.2
GS61	9	2.5
SW018	9	1.8
SW021	14	0.8
SW022	59	4.4
SW027	**26**	**4.9**
SW036	*	*
SW091	19	1.2
SW093	**100**	**1.9**
SW119	24	0.9
SW120	35	1.8

Note: [a] – Number of samples where both Pu and Am were greater than 0.015 pCi/L.
* - No results greater than 0.015 pCi/L
POEs and POCs are highlighted in **bold**.



Note: Only locations with four or more results are mapped.

Figure 4-4. Map Showing Average Pu/Am Ratios for WY97–05.

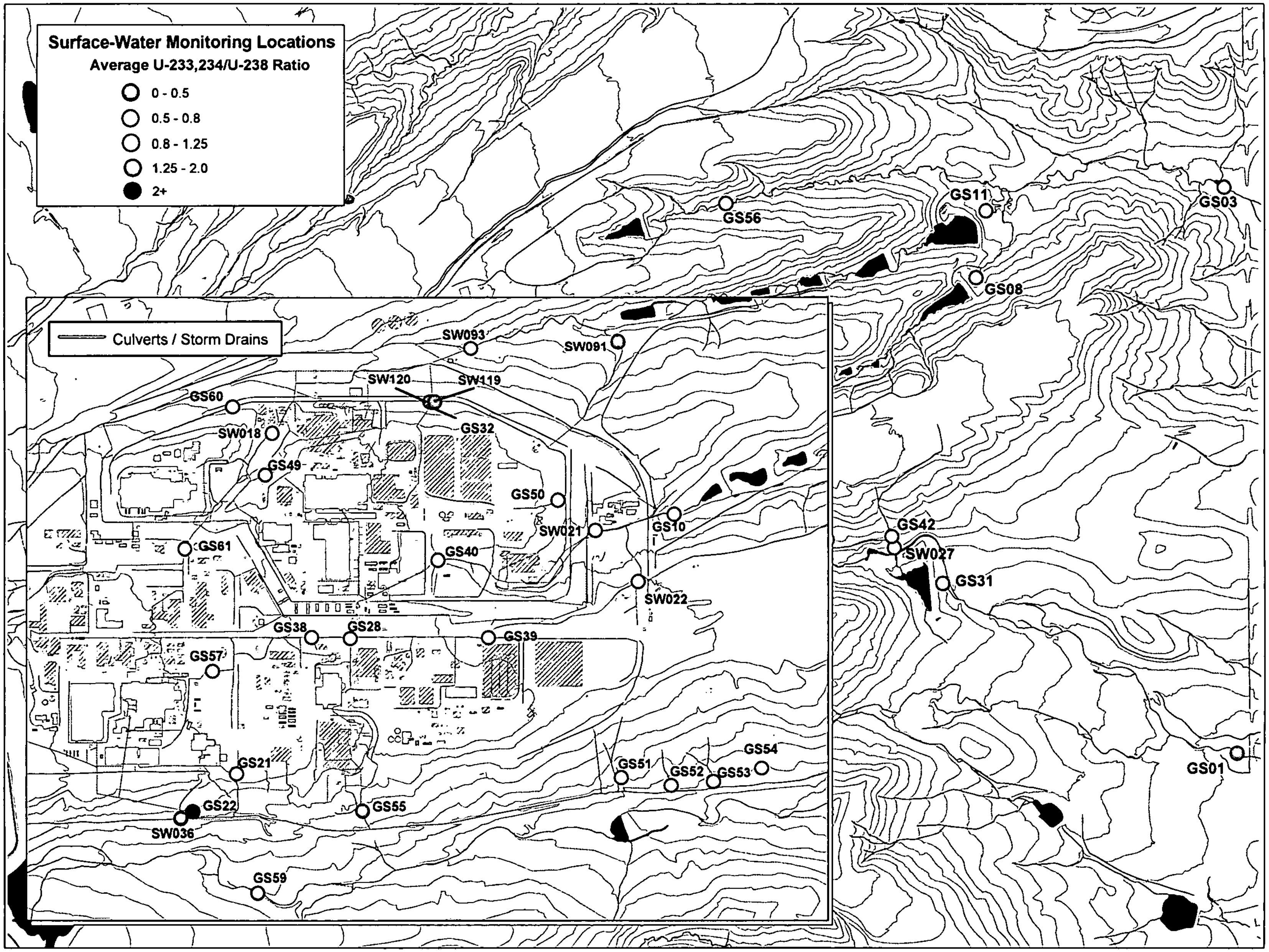
Naturally occurring uranium generally shows a U-233,234/U-238 activity ratio of approximately one. The U-233,234/U-238 activity ratios at Site surface-water monitoring locations may be used as an indication of the existence of uranium with 'unnatural' ratios. Although this evaluation does not deal systematically with analytical counting errors, Table 4-5 and Figure 4-5 are presented here for reference.

Since 1999, RFETS groundwater and surface water samples from select locations have been sent to Los Alamos National Laboratory for high resolution inductively coupled mass spectrometry (HR ICP/MS) and/or thermal ionization mass spectrometry (TIMS) analyses. These analyses measure mass ratios of the four uranium isotopes (masses 234, 235, 236, and 238) and are detailed in the reports titled "Uranium in Surface Soil, Surface Water, and Groundwater at the Rocky Flats Environmental Technology Site, dated June 2004" and in the "Interim Measure/Interim Remedial Action for Groundwater at the Rocky Flats Environmental Technology Site, dated June 21, 2005. Isotopic ratios provide a signature that indicates whether the source of uranium is natural or anthropogenic (man-made). The results indicate that all the groundwater and surface-water locations at the Site display a predominately natural signature.

Table 4-5. Average U-233,234 / U-238 Ratios for Analytical Results in WY97-05.

Location	Samples [N][a]	Average U-233,234 / U-238 Ratio
GS01	52	1.3
GS03	77	1.2
GS08	118	1.1
GS10	272	1.1
GS11	92	1.0
GS21	26	1.1
GS22	40	2.3
GS28	17	0.8
GS31	26	0.9
GS32	90	1.7
GS38	43	1.0
GS39	35	1.1
GS40	80	0.8
GS42	10	0.9
GS49	49	1.1
GS50	17	1.2
GS51	26	1.0
GS52	20	1.2
GS53	7	1.2
GS54	7	1.2
GS55	47	1.6
GS56	23	1.2
GS57	55	0.6
GS59	30	1.3
GS60	26	1.1
GS61	25	1.0
SW018	33	0.6
SW021	21	1.0
SW022	89	0.9
SW027	72	0.8
SW036	20	0.4
SW091	27	1.3
SW093	291	1.0
SW119	26	1.5
SW120	42	1.5

Note: [a] – Number of samples where both U-233,234 and U-238 were greater than 0.025 pCi/L
POEs and POCs are highlighted in **bold**.



Note: Only locations with four or more results are mapped.

Figure 4-5. Map Showing Average U-233,234 / U-238 Ratios for WY97–05.

4.2 POE METALS

The following summaries include all results that were not rejected through the validation process.[16] Data are generally presented to decimal places as reported by the laboratories. Accuracy should not be inferred; minimum detectable concentrations/activities and analytical error are often greater than the precision presented. When an 'undetect' is returned from the lab for metals analyses, then half the detection limit is used for calculation purposes. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the 'real' value and the 'duplicate'.[17] When a sample has multiple 'real' analyses (Site requested 'reruns'), the value used in calculations is the arithmetic average of the multiple 'real' analyses.[17]

Table 4-6. Summary Statistics for POE Metals Results from GS10 in WY97-05.

Analyte	Samples [N]	Undetect	Median [μg/L]	85^{th} Percentile [μg/L]	Maximum [μg/L]
Total Be	269	33.8%	0.15	0.64	3.40
Dissolved Cd	260	58.8%	0.05	0.15	1.00
Total Cr	270	14.8%	2.40	9.40	80.1
Dissolved Ag	259	89.2%	0.11	0.18	1.10

Table 4-7. Summary Statistics for POE Metals Results from SW027 in WY97-05.

Analyte	Samples [N]	Undetect	Median [μg/L]	85^{th} Percentile [μg/L]	Maximum [μg/L]
Total Be	71	45.1%	0.090	0.46	1.30
Dissolved Cd	71	70.4%	0.050	0.13	0.70
Total Cr	71	8.5%	1.700	4.00	31.2
Dissolved Ag	69	87.0%	0.110	0.23	0.72

Table 4-8. Summary Statistics for POE Metals Results from SW093 in WY97-05.

Analyte	Samples [N]	Undetect	Median [μg/L]	85^{th} Percentile [μg/L]	Maximum [μg/L]
Total Be	291	36.8%	0.12	0.55	2.10
Dissolved Cd	284	68.7%	0.05	0.14	2.20
Total Cr	290	18.3%	2.00	7.09	34.9
Dissolved Ag	280	90.0%	0.10	0.18	1.03

[16] As of the publication of this report, the last sample started in WY05 at SW027 was still in progress. Therefore, results for this sample are not included.

[17] Arithmetic averaging of metal pairs is performed only when the RPD is less than 100%. If the RPD is greater than or equal to 100%, then the metal results are determined to be non-representative. The results are then not be used for the calculation of summary statistics. A more thorough discussion of data management is given in Appendix B.1: Analytical Data Evaluation Methods.

5. LOADING ANALYSIS

This section provides a summary of actinide loads (Am, Pu, and total uranium) for RFCA POEs and POCs. These locations collect continuous flow paced composite samples for laboratory analysis. The nature of the continuous sampling during all flow conditions allows for more accurate load estimations compared to storm-event sampling. The activity for each composite sample (pCi/L) is multiplied by the corresponding stream discharge (L) during the composite sample period, to yield the load (pCi). The total pCi value is then converted to micrograms (μg) using the conversion factors in Table 5-1.[18] A detailed description of the method for load estimation is given in Appendix B1: Data Evaluation Methods.[19]

Table 5-1. Activity to Mass Conversion Factors for Pu, Am, and U Isotopes.

Analyte	Mass/Activity (g/Ci)
Pu-239,240	14.085
Am-241	0.292
U-233,234	1.6 E+02
U-235	4.63 E+05
U-238	2.98 E+06

The Pu-239,240 conversion factor was derived from Table 2.7.2-2 in the April 1980 *Final Environmental Impact Statement (Final Statement to ERDA 1545-D)*, Rocky Flats Plant Site.

The conversion factors for Am-241, U-233,234, U-235, and U-238 were taken from the *U.S. Code of Federal Regulations, Title 40, Chapter I, Part 302.4, Appendix B, October 7, 2000.*[20]

5.1 SITE-WIDE

This section summarizes the calculated site-wide Pu and Am loads for selected locations. Total uranium data collection began at GS01[21] and GS03[22] at the beginning of WY03, as such only WY03-05 data are shown. The following points are noted:

- Figure 5-1 shows that the Site retention ponds are effective at removing Pu from the water column. The A- and B-Series Ponds remove 82% of the Pu load from the IA in Walnut Creek, while Pond C-2 removes 93% of the Pu load from the IA in Woman Creek. For lower Walnut Creek, there is a small calculated Pu loss between the terminal ponds and GS03. For lower Woman Creek, however, there is a significant gain in Pu load between Pond C-2 and GS01. This is likely due to transport of diffuse, low-level Pu contamination in the much larger flow volumes measured at GS01 (2574 acre-feet [ac-ft] at GS01; 252 ac-ft at GS31). The volume-weighted Pu activity of 0.006 pCi/L at GS01 is significantly below the standard of 0.15 pCi/L.

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[18] In the following tables and plots, values are rounded for presentation.

[19] Data are generally presented at varying precision for presentation. Accuracy should not be inferred; both analytical and flow measurement error have not been quantified in this report.

[20] The U-234 conversion factor was used to represent U-233,234 due to the small relative abundance of U-233.

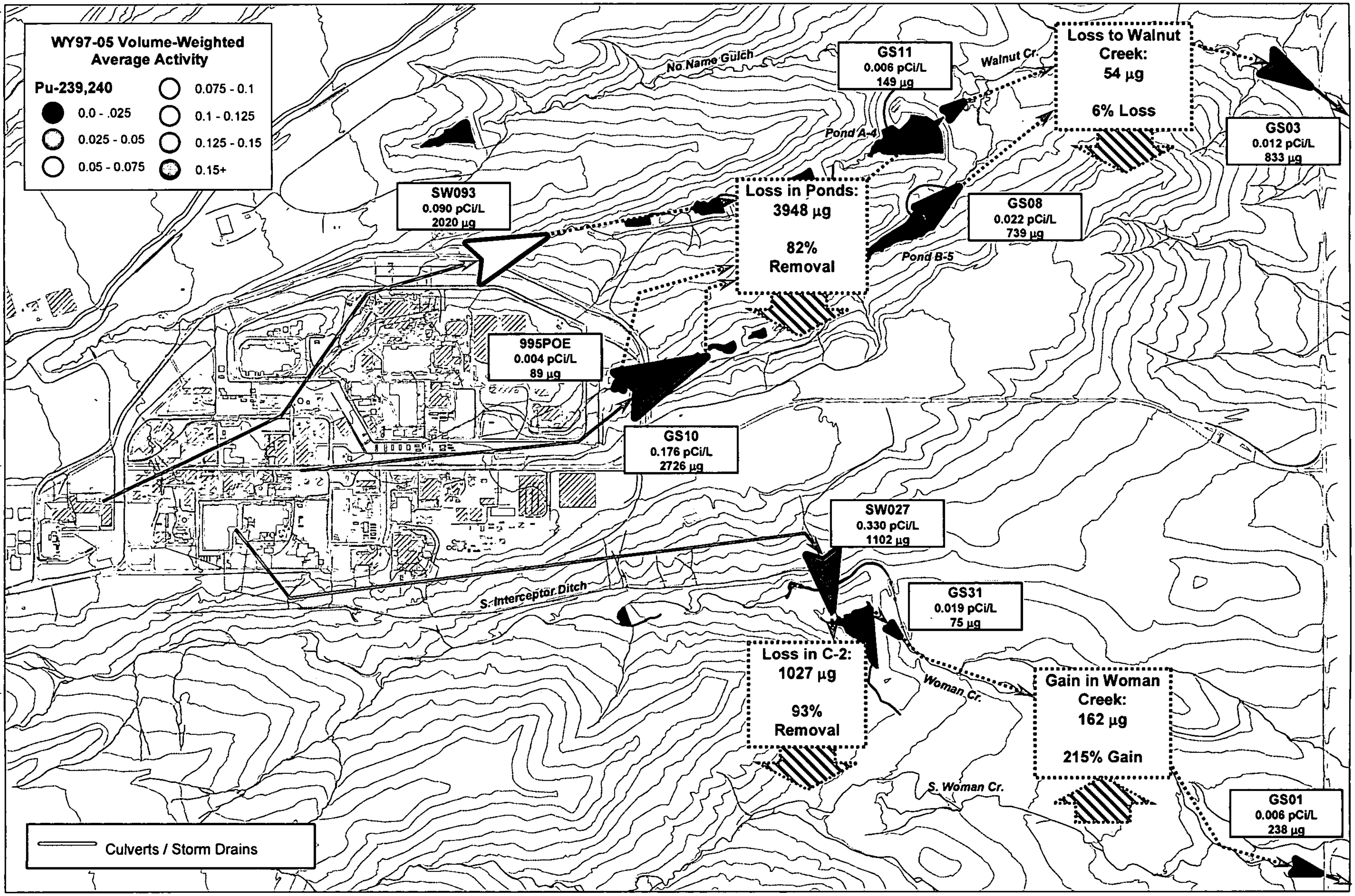
[21] As of the publication of this report, the composite sample at GS01 started on 7/1/05 was still in progress. GS01 has not flowed since 7/14/05 and the composite currently contains 3.8 liters, a non-sufficient quantity (NSQ) for analysis. Therefore, the activity for the period 7/1-10/1/05 was estimated as the volume-weighted activity for WY05 using the available data.

[22] As of the publication of this report, the composite sample at GS03 started on 7/28/05 was still in progress. GS03 has not flowed since 8/15/05 and the composite currently contains 3.8 liters, a non-sufficient quantity (NSQ) for analysis. Therefore, the activity for the period 7/28-10/1/05 was estimated as the volume-weighted activity for WY05 using the available data.

- Figure 5-2 shows that the Site retention ponds are also effective at removing Am from the water column. The A- and B-Series Ponds remove 89% of the Am load from the IA in Walnut Creek, while Pond C-2 removes a calculated 77% of the Am load from the IA in Woman Creek. For lower Walnut Creek, there is a small calculated Am gain between the terminal ponds and GS03. For lower Woman Creek, however, there is a significant percentage gain in Am load between Pond C-2 and GS01. This is likely due to transport of diffuse, low-level Am contamination in the much larger flow volumes measured at GS01 (2574 ac-ft at GS01; 252 ac-ft at GS31). The volume-weighted Am activity of 0.004 pCi/L at GS01 is significantly below the standard of 0.15 pCi/L.
- Isotopic uranium[23] analysis at both GS01 and GS03 began in WY03. Figure 5-3 shows that the Site retention ponds have very little effect on uranium activities. Since uranium is far more likely to be transported as a dissolved constituent, lack of uranium removal by physical settling is expected. In fact, the A- and B-Series Ponds show a slight gain in total uranium loads, likely caused by groundwater entering the ponds. For lower Walnut Creek, there is a 7% calculated uranium gain between the terminal ponds and GS03. For lower Woman Creek, however, there is a much larger 636% gain in uranium load between Pond C-2 and GS01. This is likely due to naturally occurring uranium in the much larger flow volumes measured at GS01 (770 ac-ft at GS01; 89 ac-ft at GS31)[24]. The volume-weighted total uranium activity of 2.02 pCi/L at GS01 is significantly below the standard of 11 pCi/L.

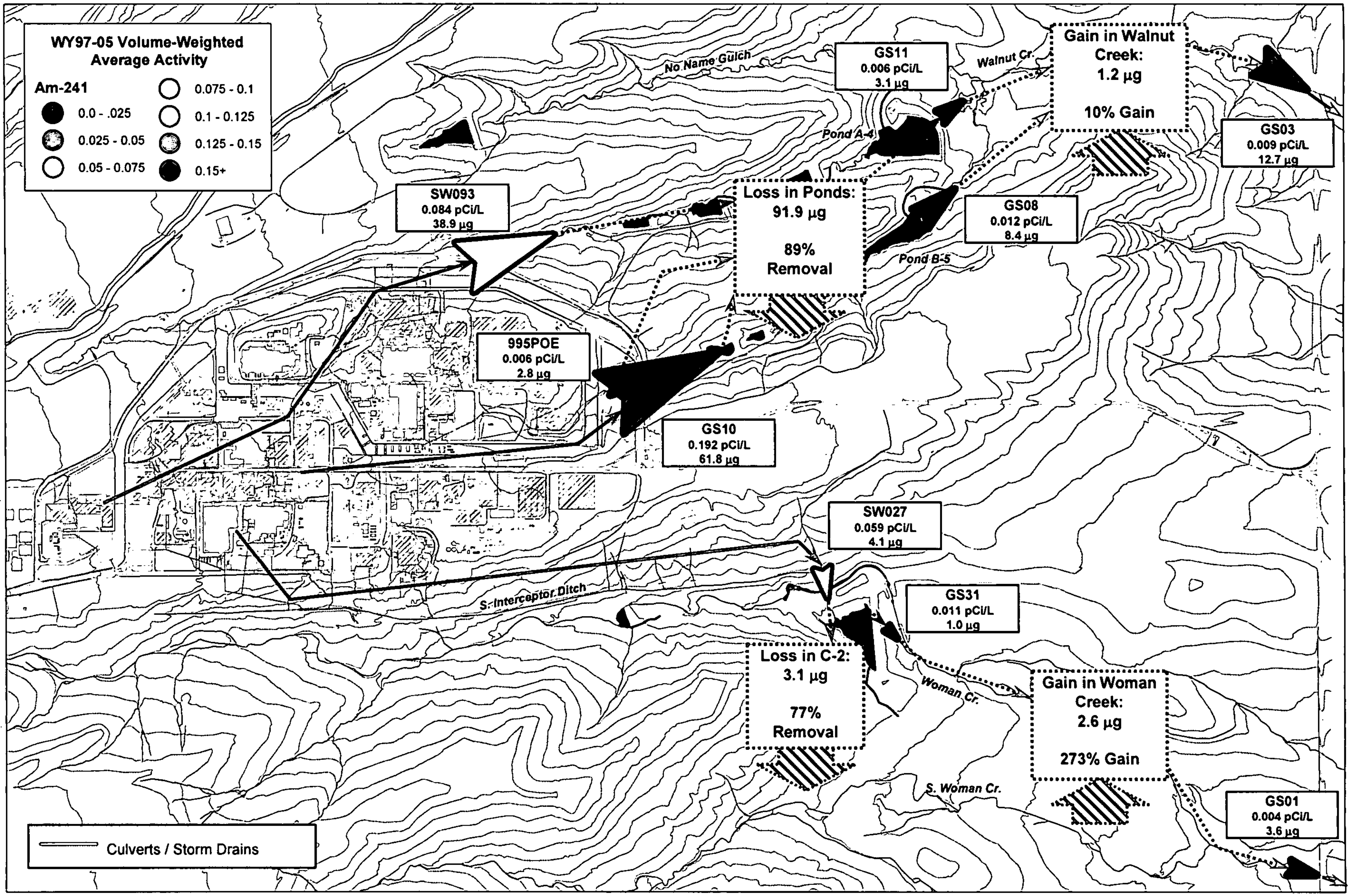
[23] Total uranium is calculated as the sum of individual isotopes: U-233.234 + U-235 + U-238

[24] For the WY03-05 period.



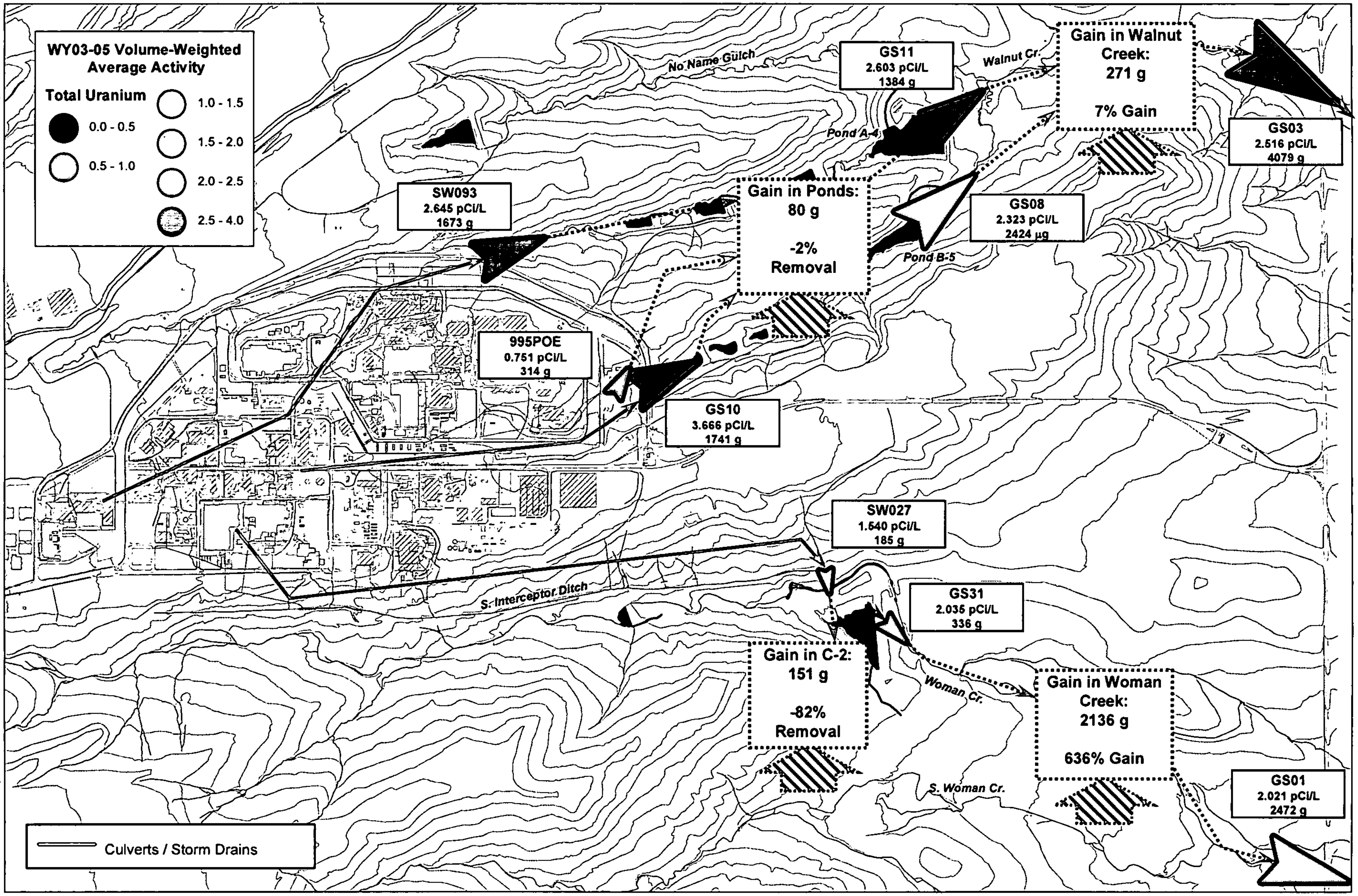
Note: Location symbols are displayed proportional to calculated load and shaded according to activity ranges in legend.

Figure 5-1. Site-Wide Relative Pu Loading Schematic: WY97-05.



Note: Location symbols are displayed proportional to calculated load and shaded according to activity ranges in legend.

Figure 5-2. Site-Wide Relative Am Loading Schematic: WY97-05.



Note: Location symbols are displayed proportional to calculated load and shaded according to activity ranges in legend.

Figure 5-3. Site-Wide Relative Total Uranium Loading Schematic: WY03-05.

5.2 FENCELINE POINTS OF COMPLIANCE

This section summarizes the calculated offsite Pu and Am loads from Walnut[25] and Woman[26] Creeks. The following points are noted:

- Walnut Creek accounts for 78% of both the Pu (Figure 5-6) and Am (Figure 5-8) loads from the Site. The fact that Walnut Creek accounts for 61% of the combined Walnut and Woman Creek flow volumes (Section 3.2.1) show that the activities in Walnut Creek are somewhat higher than Woman Creek.
- Both Pu and Am loads have decreased in recent years as Site closure activities are likely to have reduced discharge volumes and eliminated source terms (Figure 5-4).
- Uranium analysis at both GS01 and GS03 began in WY03. Walnut Creek accounts for 62% of the total uranium (Figure 5-10) load from the Site for WY03-05.

Table 5-2. Offsite Pu and Am Loads from Walnut and Woman Creeks: WY97–05.

	Pu-239,240 (µg)			Am-241 (µg)		
Water Year	**Walnut Creek**	**Woman Creek**	**Site Total**	**Walnut Creek**	**Woman Creek**	**Site Total**
1997	254.7	47.8	302.5	2.60	0.49	3.09
1998	181.3	59.1	240.4	2.84	1.01	3.84
1999	148.9	56.1	205.0	2.06	0.77	2.83
2000	23.7	6.6	30.3	0.75	0.18	0.93
2001	59.0	23.7	82.7	0.65	0.30	0.96
2002	43.2	1.0	44.2	0.32	0.04	0.35
2003	57.3	25.9	83.2	0.98	0.34	1.32
2004	33.2	3.6	36.8	0.82	0.10	0.93
2005	31.9	13.6	45.6	1.71	0.35	2.06
Total	833.2	237.5	1070.7	12.72	3.57	16.30

Note: During WY97, flows from Woman Creek were routinely diverted to Mower Ditch for subsequent monitoring at GS02 (Figure 3-1). Therefore, the load calculated for Woman Creek at Indiana Street (GS01) includes the water that was measured at GS02. The estimated load diverted to GS02 is calculated by multiplying the WY97 volume-weighted activities at GS01 by the streamflow volume measured at GS02, and converting for units. This diverted load is then added to the calculated load at GS01 to obtain the total WY97 load at GS01. For subsequent water years, the Mower diversion structure has been upgraded and configured to prevent Woman Creek flows from entering the Mower Ditch.

[25] As of the publication of this report, the composite sample at GS03 started on 7/28/05 was still in progress. GS03 has not flowed since 8/15/05 and the composite currently contains 3.8 liters, a non-sufficient quantity (NSQ) for analysis. Therefore, the activity for the period 7/28-10/1/05 was estimated as the volume-weighted activity for WY05 using the available data.

[26] As of the publication of this report, the composite sample at GS01 started on 7/1/05 was still in progress. GS01 has not flowed since 7/14/05 and the composite currently contains 3.8 liters, a non-sufficient quantity (NSQ) for analysis. Therefore, the activity for the period 7/1-10/1/05 was estimated as the volume-weighted activity for WY05 using the available data.

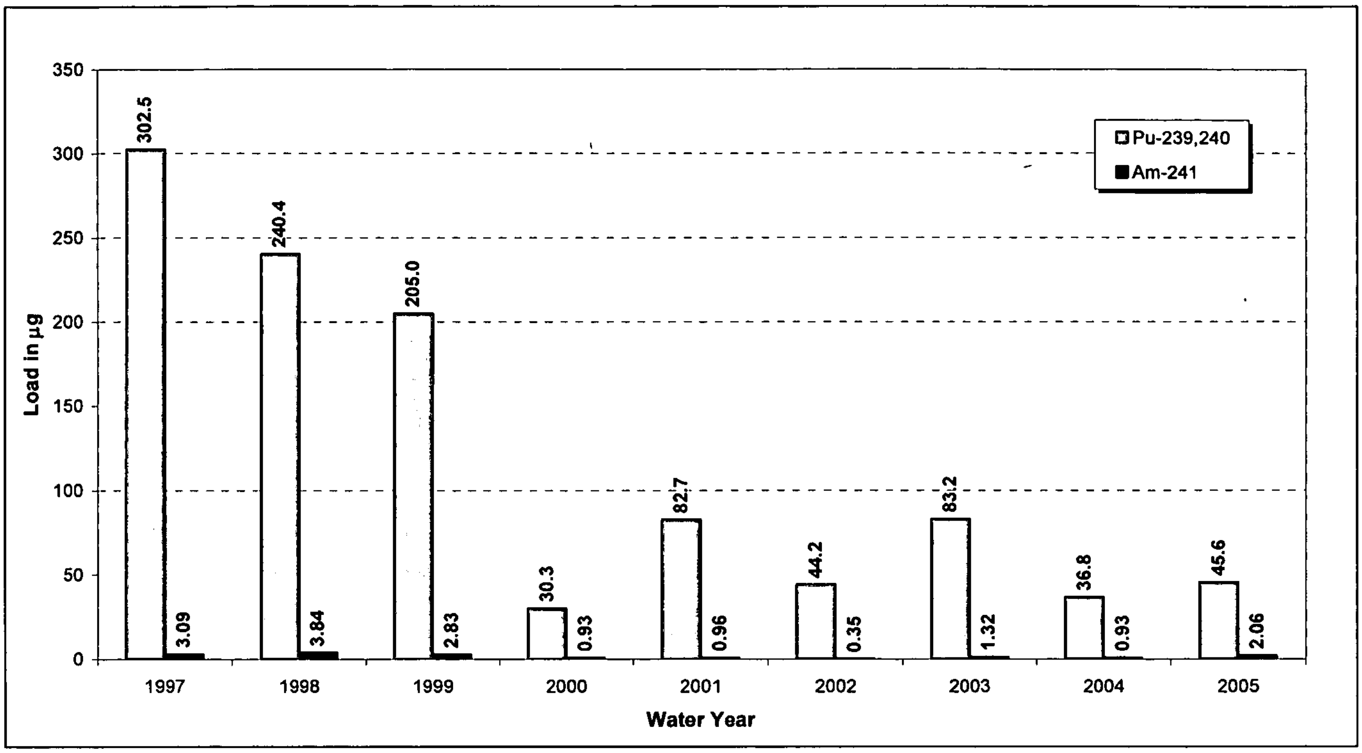


Figure 5-4. Combined Annual Pu and Am Loads from Walnut and Woman Creeks: WY97–05.

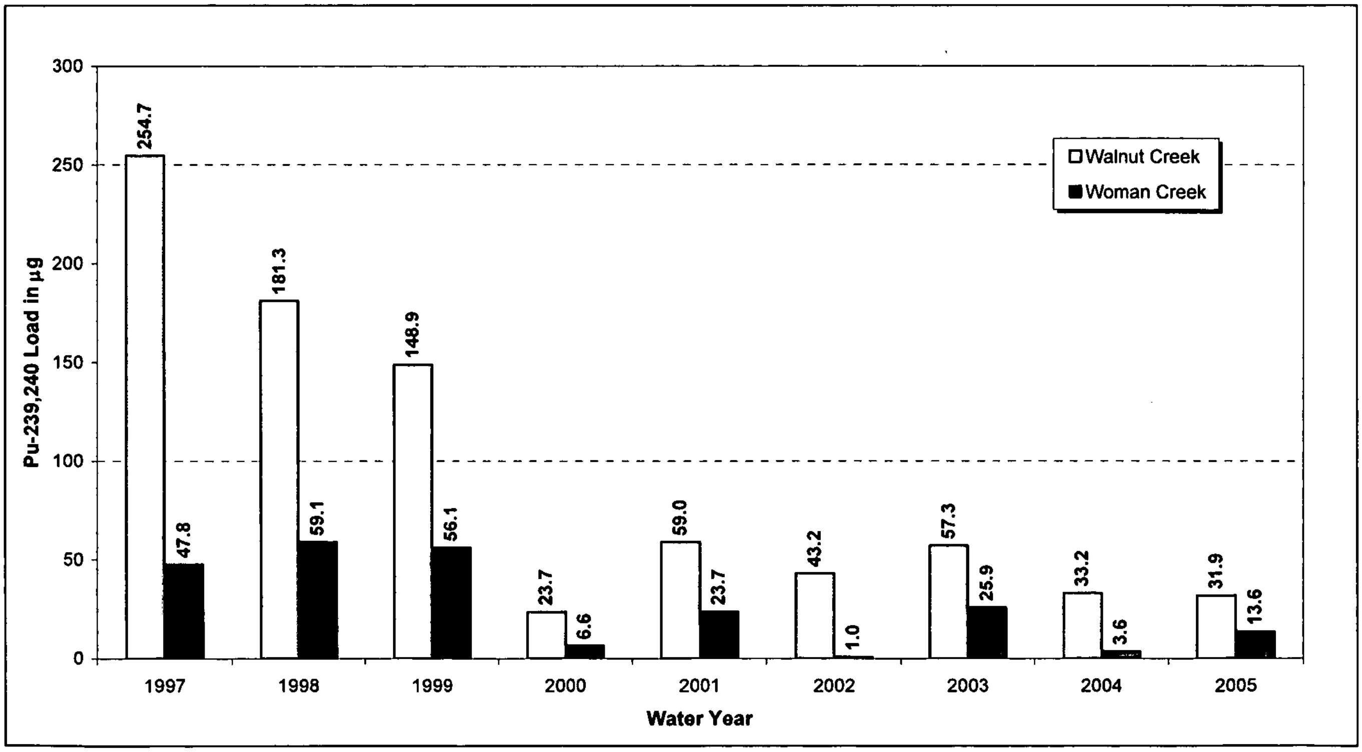


Figure 5-5. Annual Pu Loads from Walnut and Woman Creeks: WY97–05.

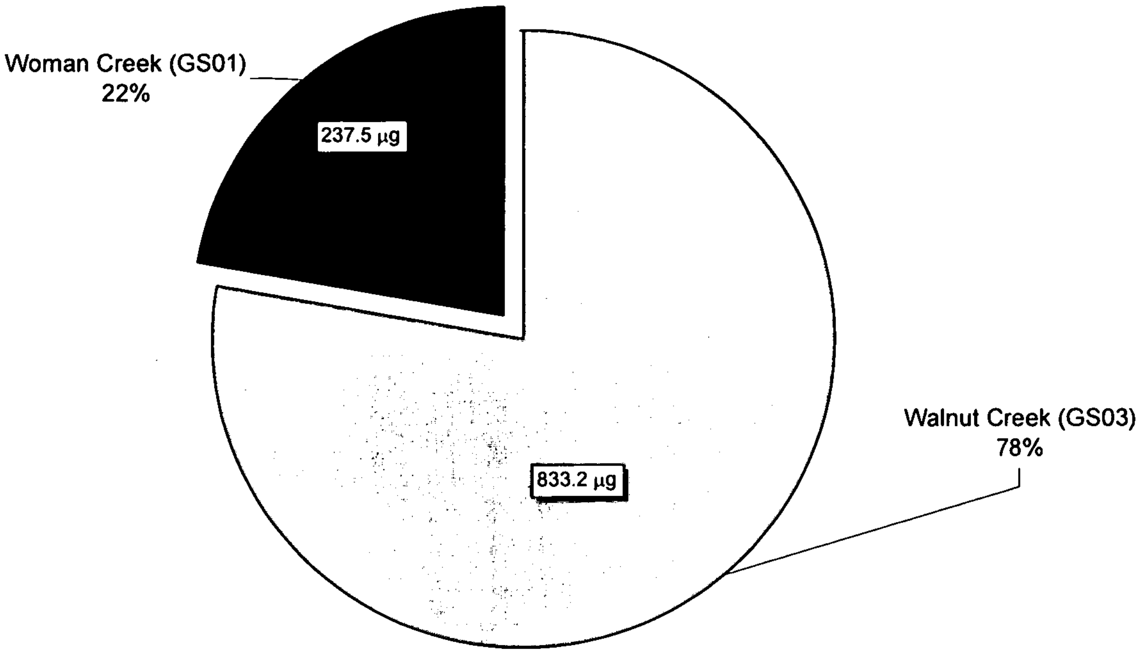


Figure 5-6. Relative Pu Load Totals from Walnut and Woman Creeks: WY97–05.

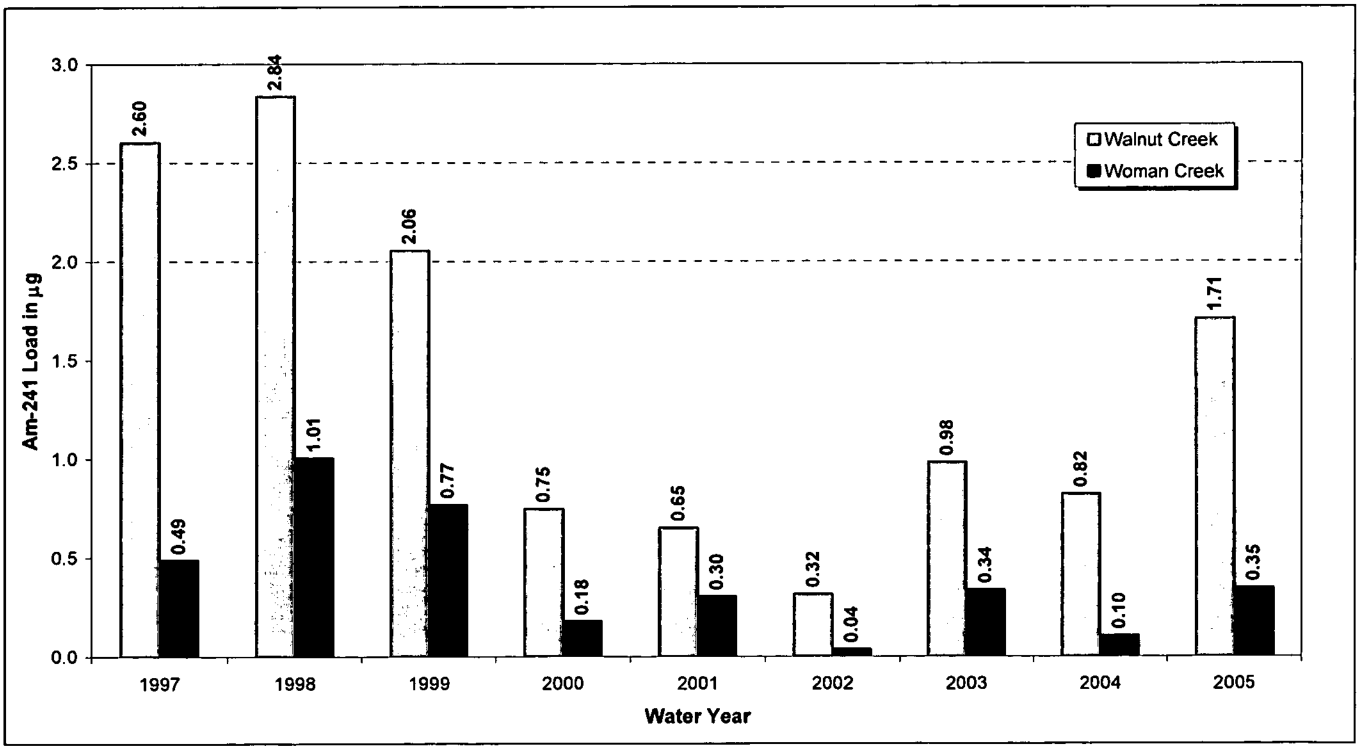


Figure 5-7. Annual Am Loads from Walnut and Woman Creeks: WY97–05.

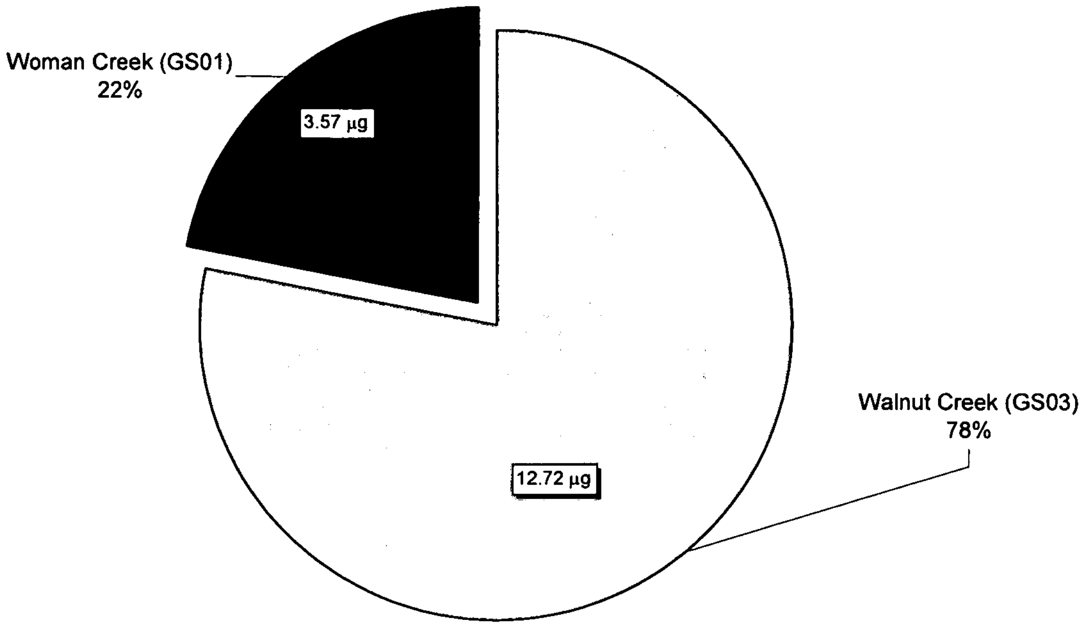


Figure 5-8. Relative Am Load Totals from Walnut and Woman Creeks: WY97–05.

Table 5-3. Total Uranium Loads from Walnut and Woman Creeks: WY03-05.

	Total Uranium (g)	
Water Year	**Walnut Creek**	**Woman Creek**
2003	1750	788
2004	823	333
2005	1506	1351
Total	4079	2472

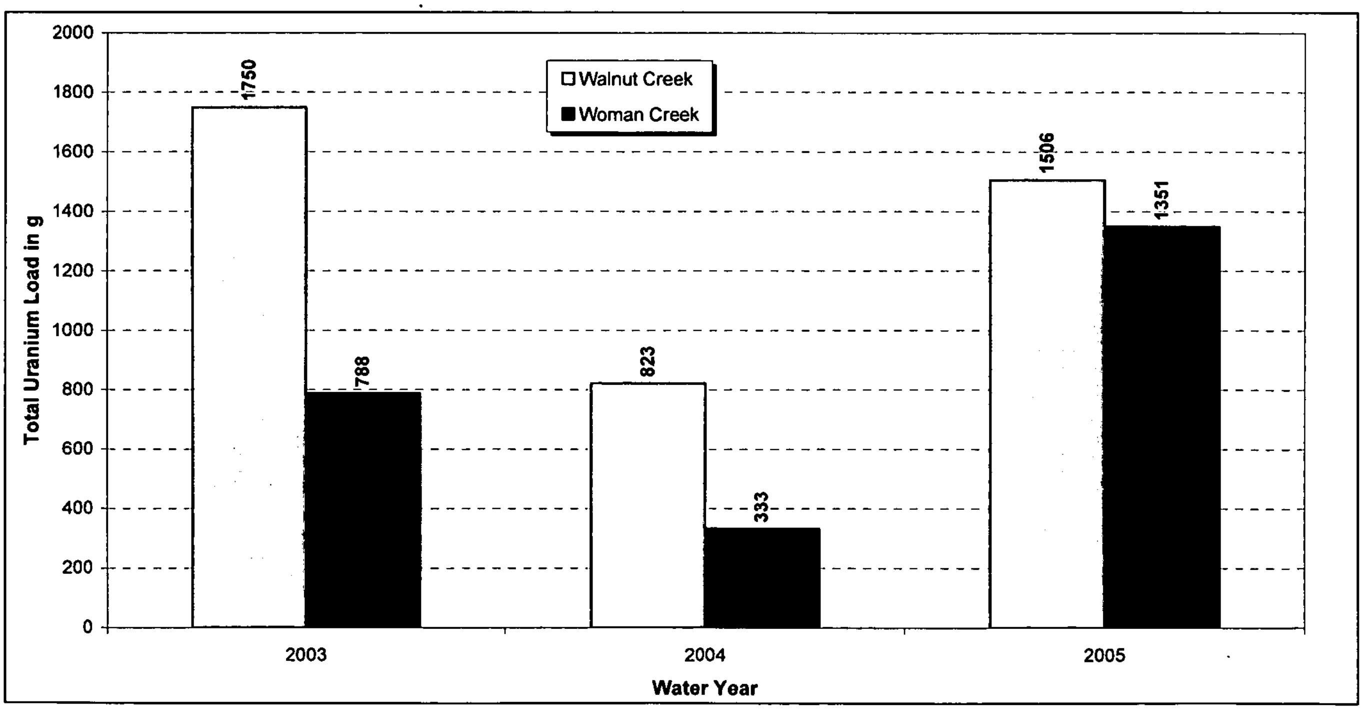


Figure 5-9. Annual Total Uranium Loads from Walnut and Woman Creeks: WY03–05.

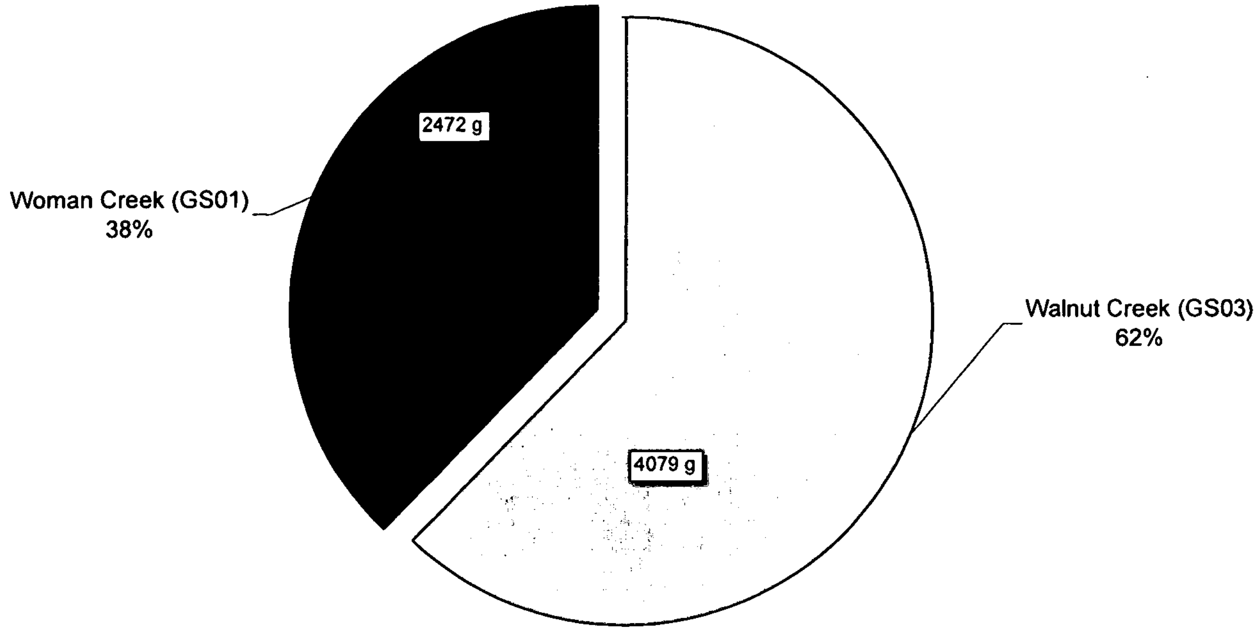


Figure 5-10. Relative Total Uranium Load from Walnut and Woman Creeks: WY03-05.

5.3 WALNUT CREEK (POC GS03)

This section summarizes the calculated Pu and Am loads in Walnut Creek at GS03[27] (Walnut and Indiana Street), GS08 (Pond B-5), and GS11 (Pond A-4). Total uranium data collection began at GS03 on 11/5/02, as such only WY03-05 data are shown. The following points are noted:

- Annual Pu and Am loads vary by up to two orders of magnitude year-to-year (Figure 5-12 and Figure 5-15).
- Pu and Am loads appear to be decreasing at GS03 (Figure 5-11). The slight increase in Am loads at GS03 during WY05 is due to increased Am contributions in N. Walnut Creek associated with B771 D&D (see Section 6.3.3). Treatment of Pond A-4 water was successful in reducing Am levels well below the applicable standard (0.15 pCi/l), but the Am activity of the discharged water was somewhat higher than normal. Pond B-5 also showed some increased Am activity due to temporarily increased Am load associated with solids transport resulting from the construction of Functional Channel #4. These slightly higher Am activities were subsequently measured at GS03.
- Pu and Am loads from B-5 are significantly greater than loads from A-4 (Table 5-4 and Table 5-5), a result of both higher activities and larger discharge volumes.
- Total Pu loads from A-4 and B-5 are marginally greater than the loads at GS03 (Table 5-4 and Figure 5-13), indicating a small loss of load (-6%) to the Walnut Creek streambed below A-4 and B-5.
- Total Am loads from A-4 and B-5 are marginally less than the loads at GS03 (Table 5-5 and Figure 5-16), indicating a small gain of load (10%) from tributaries and the Walnut Creek streambed below A-4 and B-5.
- Total WY03-05 uranium loads from A-4 and B-5 are less than the loads at GS03 (Figure 5-19), indicating a small gain of load (7%) from tributaries and the Walnut Creek streambed below A-4 and B-5.

[27] As of the publication of this report, the composite sample at GS03 started on 7/28/05 was still in progress. GS03 has not flowed since 8/15/05 and the composite currently contains 3.8 liters, a non-sufficient quantity (NSQ) for analysis. Therefore, the activity for the period 7/28-10/1/05 was estimated as the volume-weighted activity for WY05 using the available data.

Table 5-4. Pu Loads at GS03, GS08, and GS11: WY97–05.

	Pu-239,240 (μg)				
Water Year	**Pond A-4 [GS11]**	**Pond B-5 [GS08]**	**Walnut Cr. Terminal Ponds**	**POC GS03**	**Percent Gain/Loss**
1997	46.0	13.7	59.7	254.7	327%
1998	30.7	22.4	53.1	181.3	241%
1999	27.0	255.9	283.0	148.9	-47%
2000	27.9	245.3	273.2	23.7	-91%
2001	5.3	32.0	37.3	59.0	58%
2002	0.1	12.9	13.0	43.2	233%
2003	5.4	111.5	116.9	57.3	-51%
2004	4.1	26.2	30.3	33.2	9%
2005	2.2	18.8	21.0	31.9	52%
Total	148.6	738.8	887.4	833.2	-6%

Table 5-5. Am Loads at GS03, GS08, and GS11: WY97–05.

	Am-241 (μg)				
Water Year	**Pond A-4 [GS11]**	**Pond B-5 [GS08]**	**Walnut Cr. Terminal Ponds**	**POC GS03**	**Percent Gain/Loss**
1997	0.52	0.27	0.79	2.60	231%
1998	1.33	0.40	1.73	2.84	64%
1999	0.35	1.73	2.08	2.06	-1%
2000	0.02	3.16	3.18	0.75	-76%
2001	0.11	0.46	0.57	0.65	14%
2002	0.02	0.27	0.29	0.32	10%
2003	0.20	0.45	0.64	0.98	53%
2004	0.14	0.72	0.86	0.82	-4%
2005	0.43	0.98	1.41	1.71	21%
Total	3.12	8.42	11.54	12.72	10%

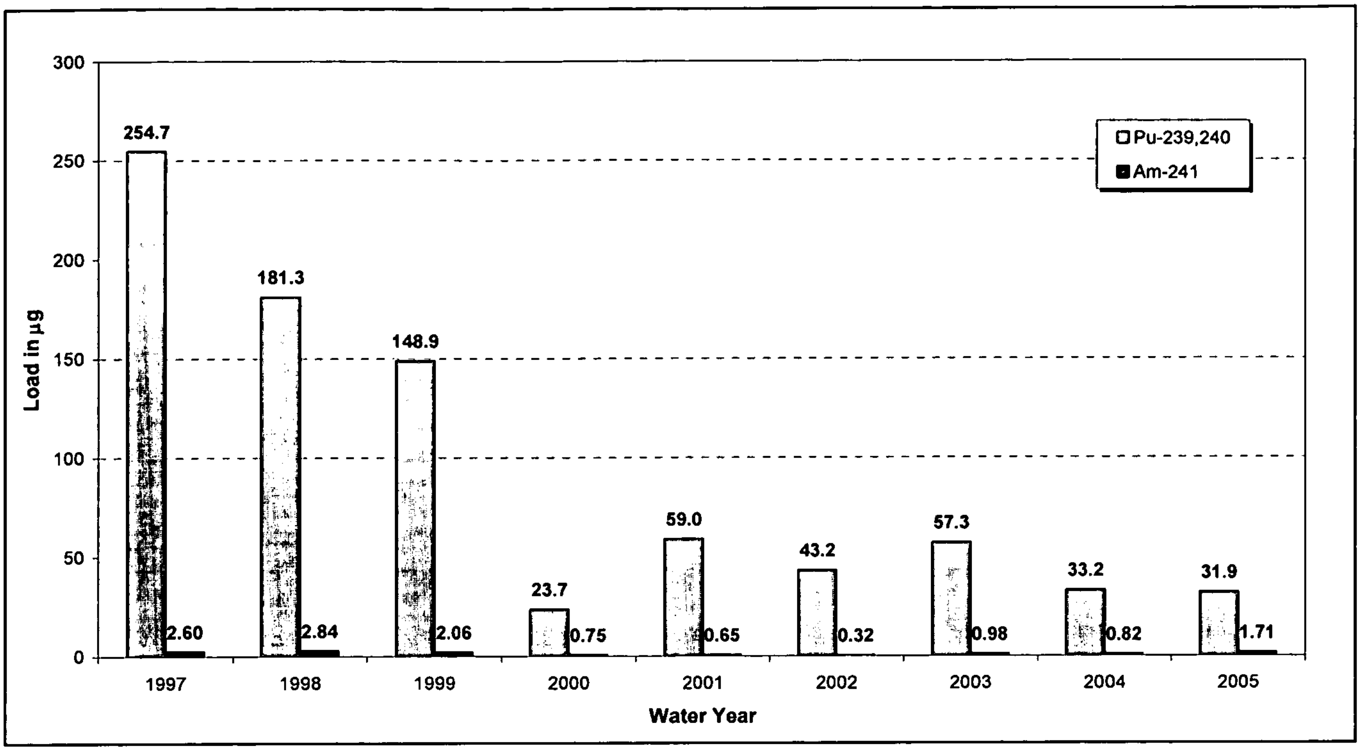


Figure 5-11. Annual Pu and Am Loads at GS03: WY97–05.

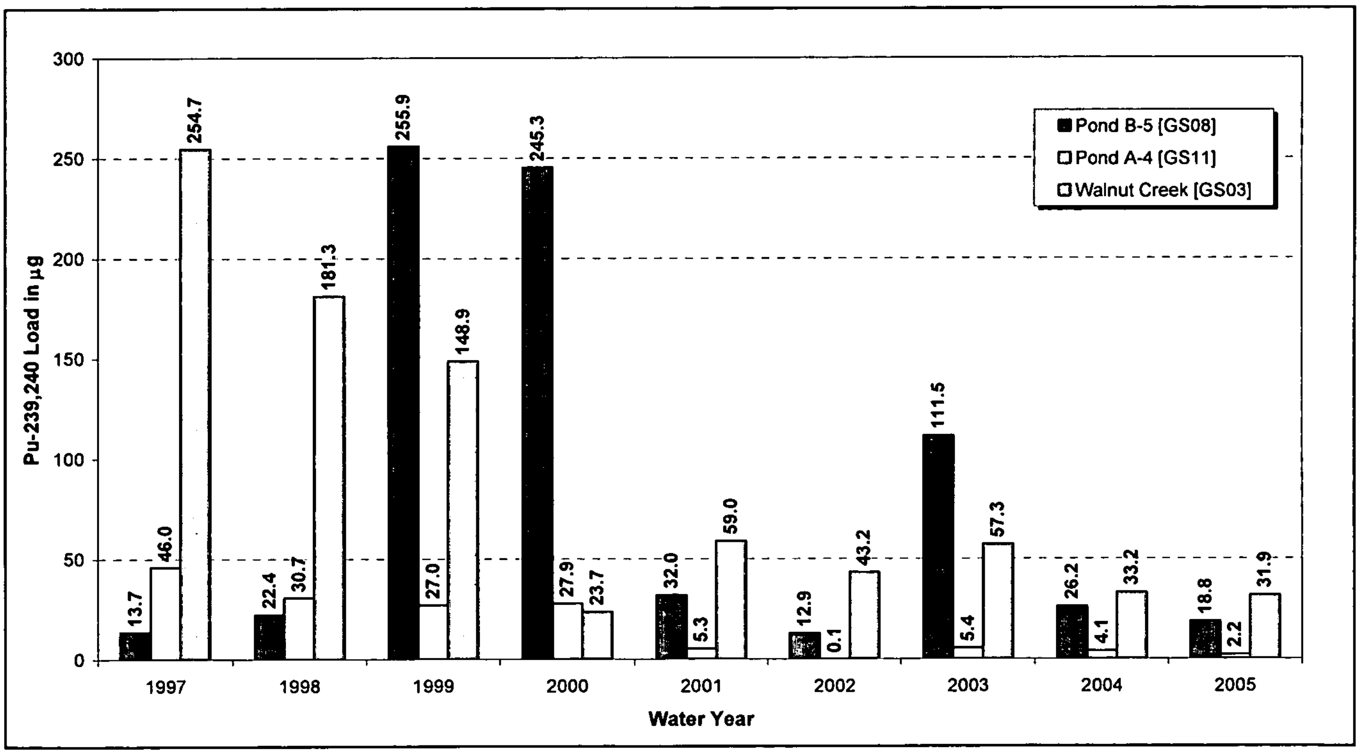


Figure 5-12. Annual Pu Loads at GS03, GS08, and GS11: WY97–05.

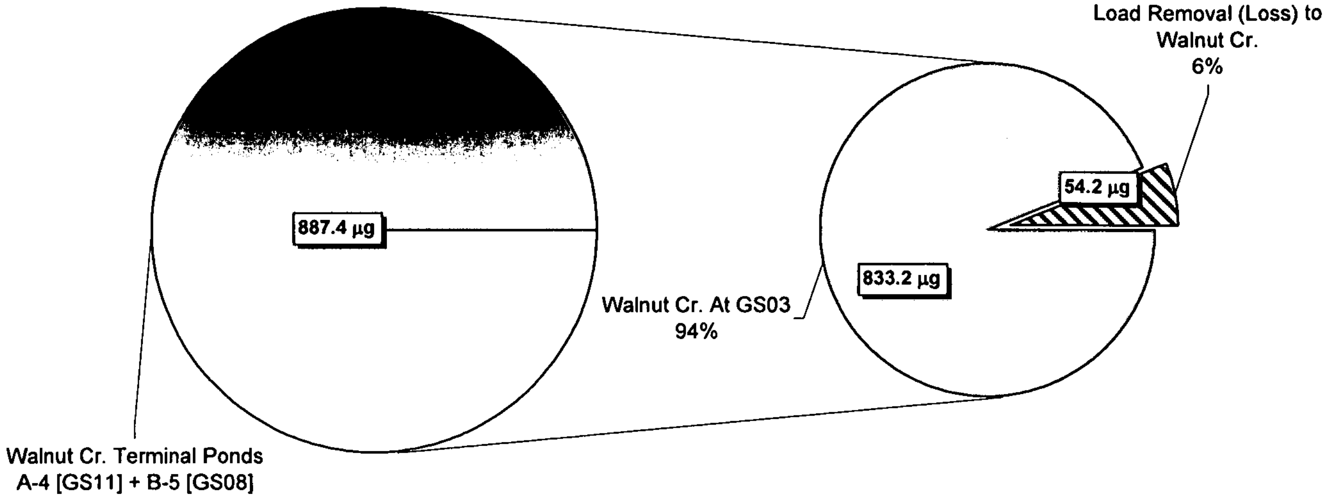


Figure 5-13. Relative Pu Load Totals at GS03, GS08, and GS11: WY97–05.

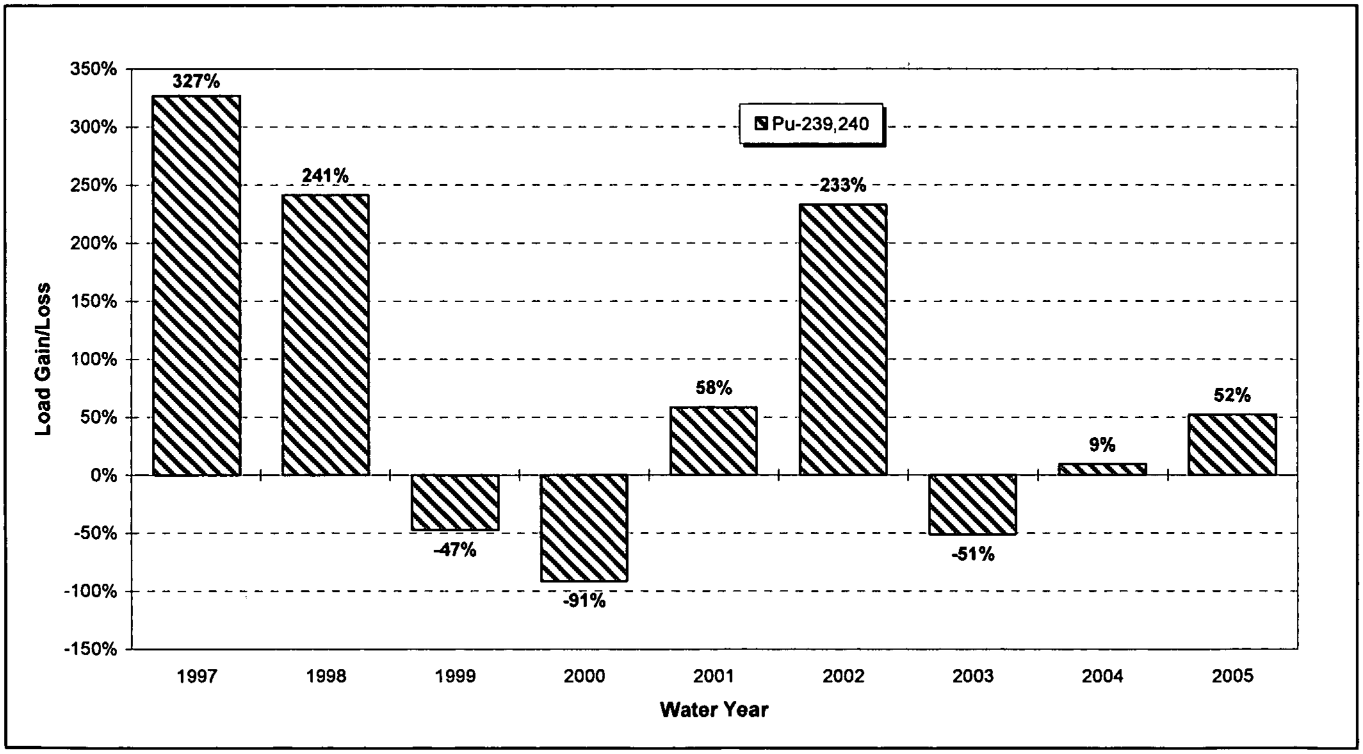


Figure 5-14. Annual Pu Load Gain/Loss for Walnut Creek: WY97–05.

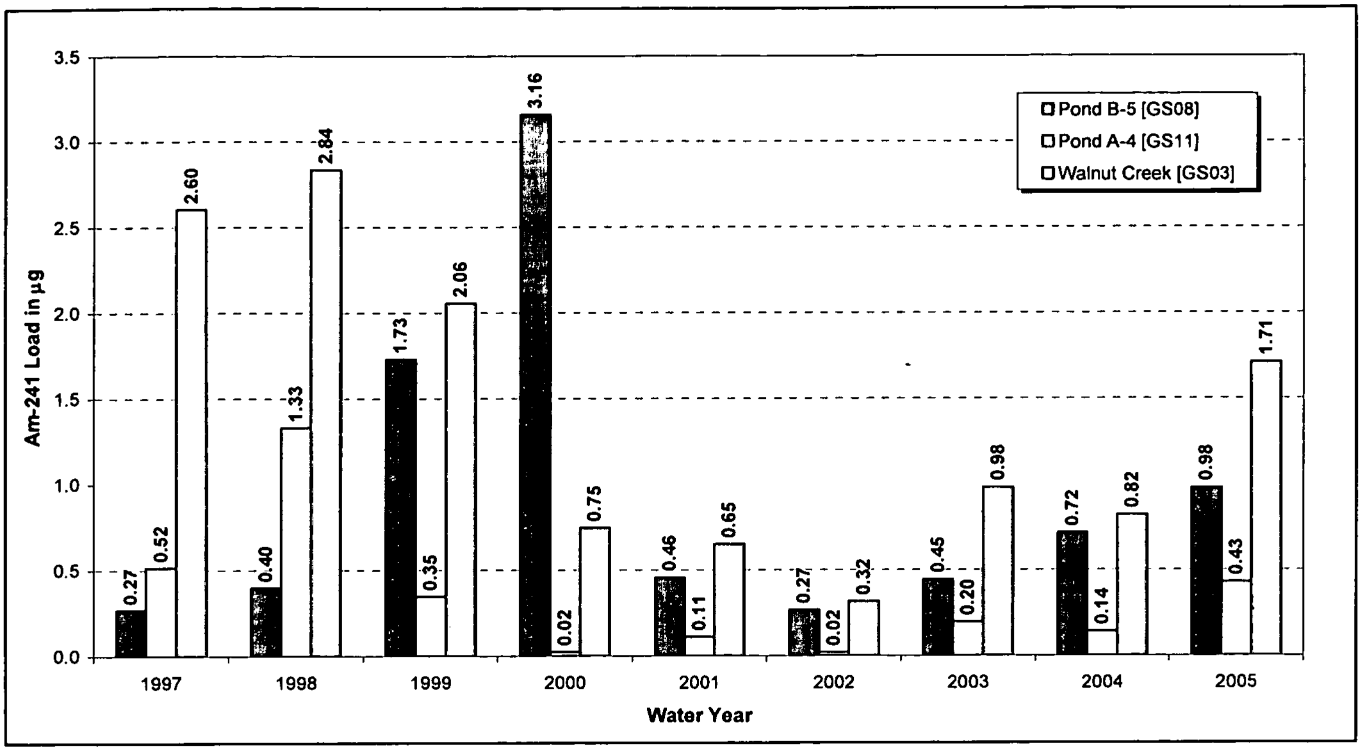


Figure 5-15. Annual Am Loads at GS03, GS08, and GS11: WY97–05.

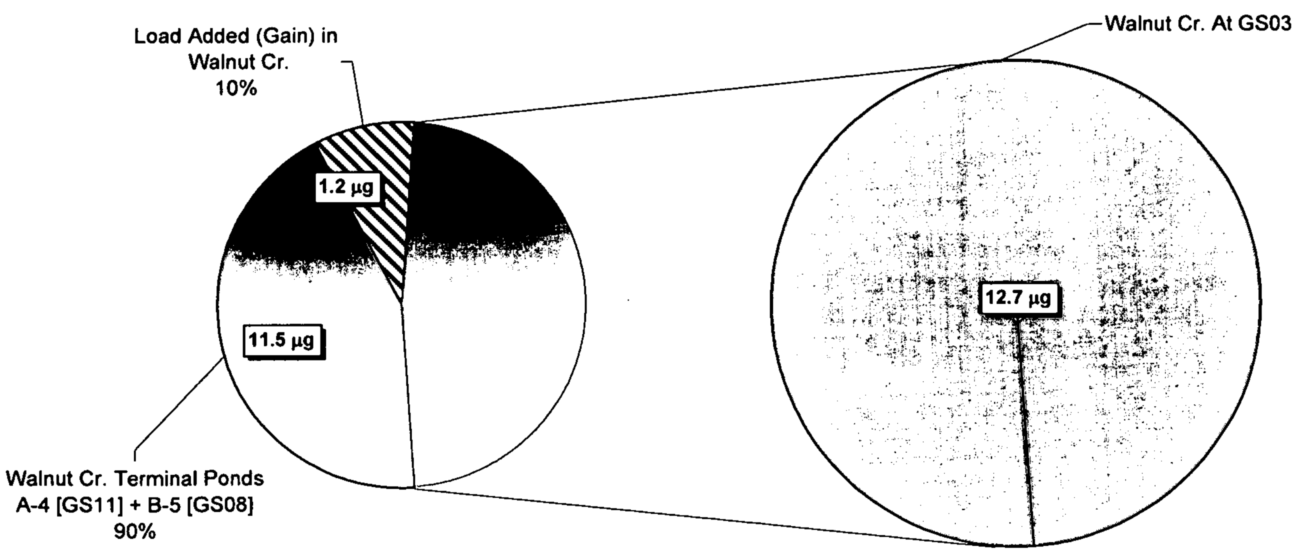


Figure 5-16. Relative Am Load Totals at GS03, GS08, and GS11: WY97–05.

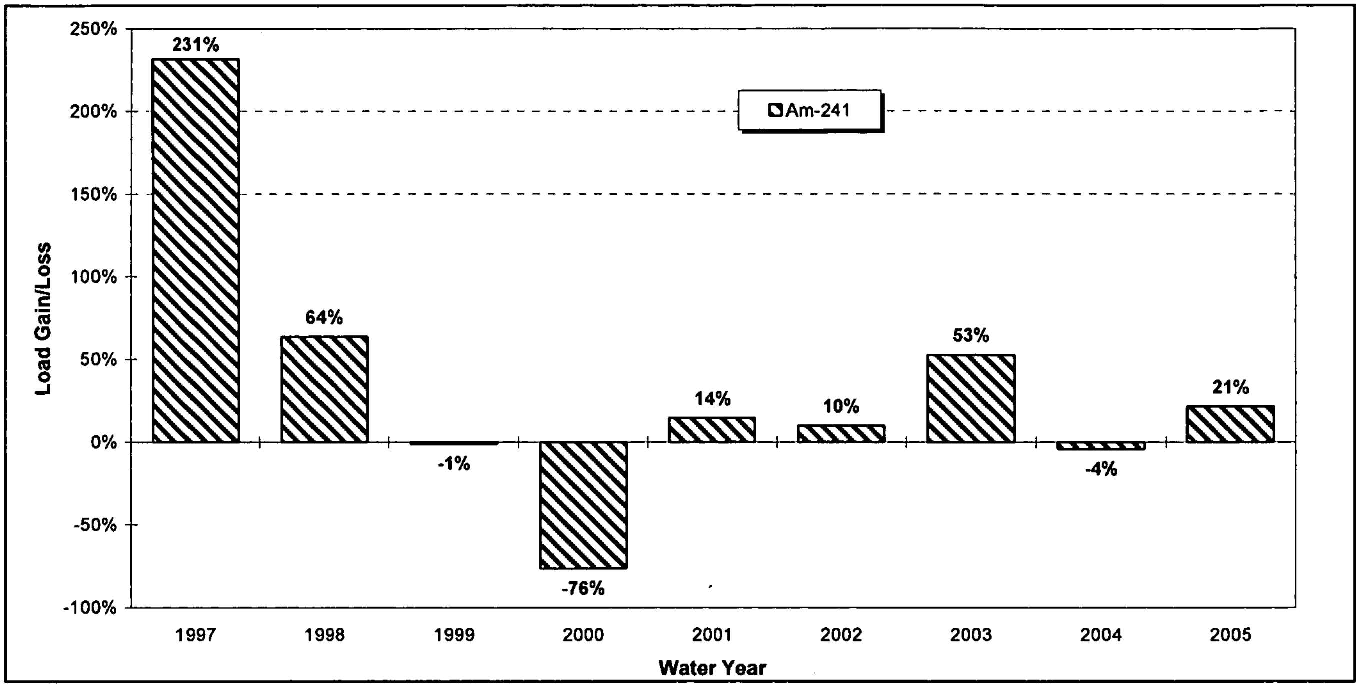


Figure 5-17. Annual Am Load Gain/Loss for Walnut Creek: WY97–05.

Table 5-6. Total Uranium Loads at GS03, GS08, and GS11: WY03-05.

	Total Uranium (g)				
Water Year	**Pond A-4 [GS11]**	**Pond B-5 [GS08]**	**Walnut Cr. Terminal Ponds**	**POC GS03**	**Percent Gain/Loss**
2003	855	595	1451	1750	21%
2004	364	418	782	823	5%
2005	165	1411	1575	1506	-4%
Total	1384	2424	3808	4079	7%

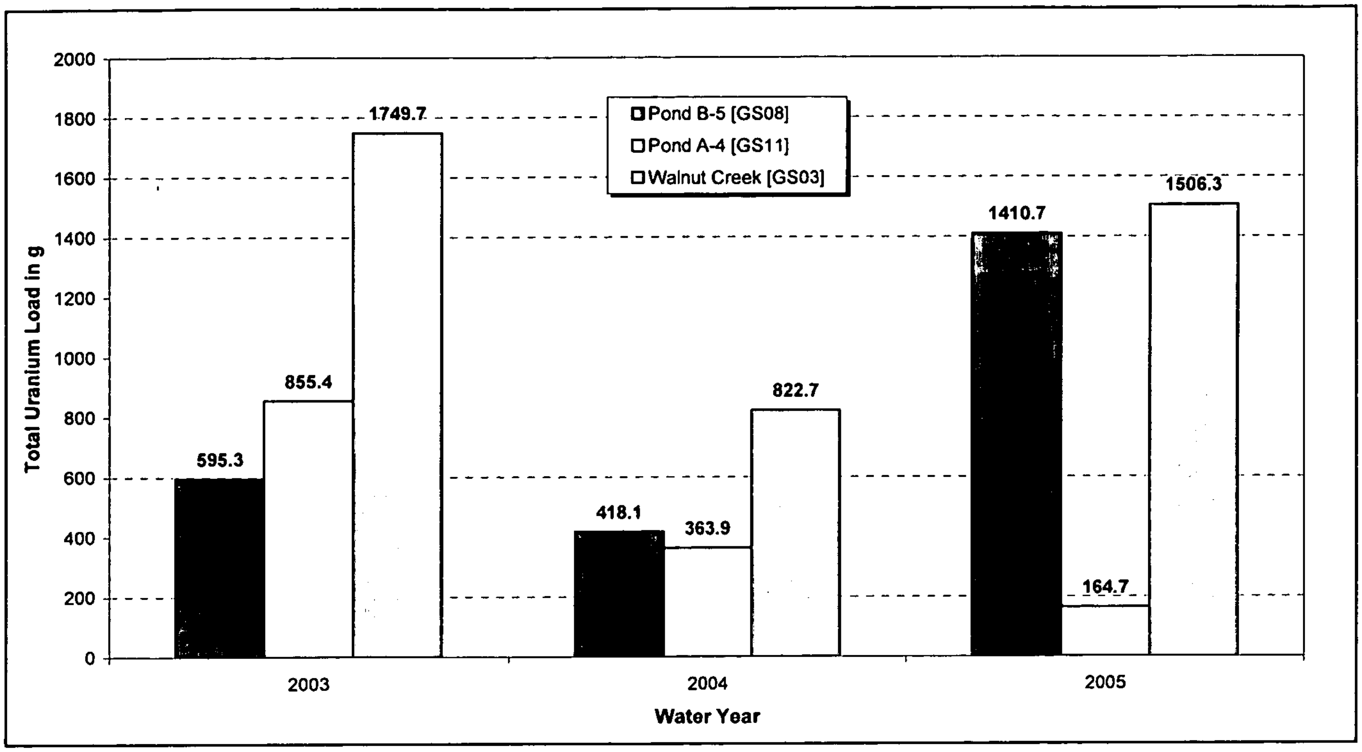


Figure 5-18. Annual Total Uranium Loads at GS03, GS08, and GS11: WY03-05.

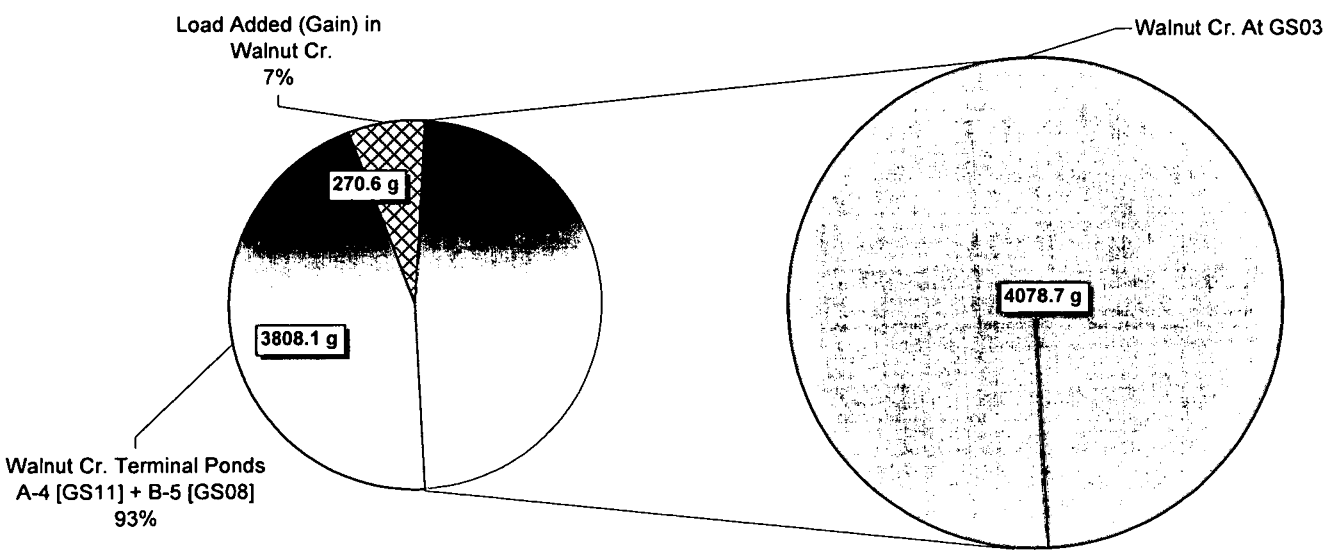


Figure 5-19. Relative Total Uranium Load Totals at GS03, GS08, and GS11: WY03-05.

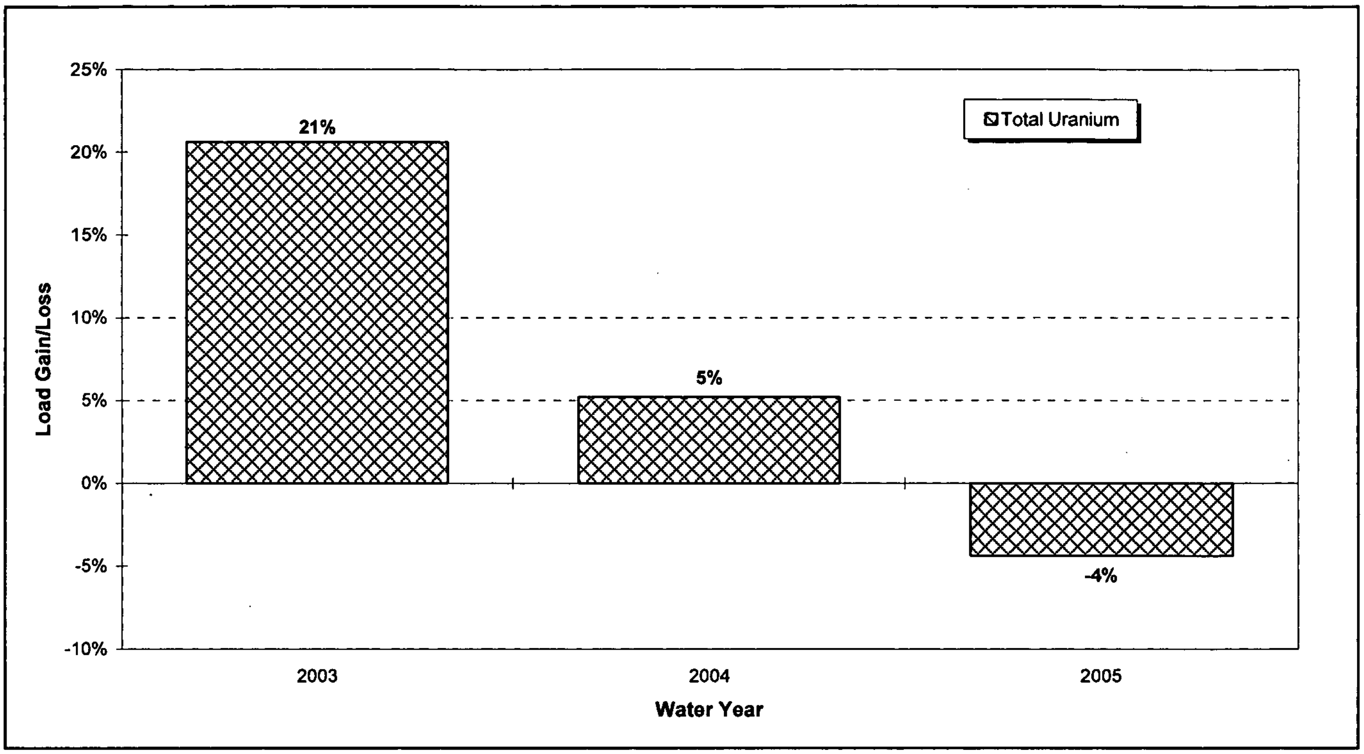


Figure 5-20. Annual Total Uranium Load Gain/Loss for Walnut Creek: WY03–05.

5.4 WOMAN CREEK (POC GS01)

This section summarizes the calculated Pu and Am loads in Woman Creek at GS01[28] (Woman Cr. at Indiana Street) and GS31 (Pond C-2). Total uranium data collection began at GS01 on 2/3/03, as such only WY03-05 data are shown. The following points are noted:

- Annual Pu and Am loads generally vary by up to two orders of magnitude year-to-year (Figure 5-22 and Figure 5-25).
- Pu and Am loads appear to be decreasing at GS01 (Figure 5-21).
- Total Pu loads from C-2 are significantly less than the loads at GS01 (Figure 5-23), indicating a significant gain of load from the Woman Creek drainage (215%).
- Total Am loads from C-2 are significantly less than the loads at GS01 (Figure 5-26), indicating a significant gain of load from the Woman Creek drainage (273%).
- Total WY03-05 uranium load from C-2 is significantly less than the load at GS01 (Figure 5-29), indicating a significant gain of load (636%) from tributaries and the Woman Creek drainage area below C-2.

[28] As of the publication of this report, the composite sample at GS01 started on 7/1/05 was still in progress. GS01 has not flowed since 7/14/05 and the composite currently contains 3.8 liters, a non-sufficient quantity (NSQ) for analysis. Therefore, the activity for the period 7/1-10/1/05 was estimated as the volume-weighted activity for WY05 using the available data.

Table 5-7. Pu Loads at GS01 and GS31: WY97–05.

	Pu-239,240 (µg)		
Water Year	**Pond C-2 [GS31]**	**POC GS01**	**Percent Gain/Loss**
1997	6.8	47.8	605%
1998	12.1	59.1	389%
1999	26.9	56.1	108%
2000	0.0; No C-2 Discharge	6.6	NA
2001	11.0	23.7	116%
2002	0.2	1.0	340%
2003	11.0	25.9	136%
2004	0.0; No C-2 Discharge	3.6	NA
2005	7.3	13.6	88%
Total	75.3	237.5	215%

Note: During WY97, flows from Woman Creek were routinely diverted to Mower Ditch for subsequent monitoring at GS02 (Figure 3-1). Therefore, the load calculated for Woman Creek at Indiana Street (GS01) includes the water that was measured at GS02. The estimated load diverted to GS02 is calculated by multiplying the WY97 volume-weighted activities at GS01 by the streamflow volume measured at GS02, and converting for units. This diverted load is then added to the calculated load at GS01 to obtain the total WY97 load at GS01. For subsequent water years, the Mower diversion structure has been upgraded and configured to prevent Woman Creek flows from entering the Mower Ditch.

Table 5-8. Am Loads at GS01 and GS31: WY97–05.

	Am-241 (µg)		
Water Year	**Pond C-2 [GS31]**	**POC GS01**	**Percent Gain/Loss**
1997	0.04	0.49	1121%
1998	0.40	1.01	150%
1999	0.13	0.77	497%
2000	0.00; No C-2 Discharge	0.18	NA
2001	0.14	0.30	115%
2002	0.00	0.04	4640%
2003	0.09	0.34	261%
2004	0.00; No C-2 Discharge	0.10	NA
2005	0.15	0.35	131%
Total	0.96	3.57	273%

Note: During WY97, flows from Woman Creek were routinely diverted to Mower Ditch for subsequent monitoring at GS02 (Figure 3-1). Therefore, the load calculated for Woman Creek at Indiana Street (GS01) includes the water that was measured at GS02. The estimated load diverted to GS02 is calculated by multiplying the WY97 volume-weighted activities at GS01 by the streamflow volume measured at GS02, and converting for units. This diverted load is then added to the calculated load at GS01 to obtain the total WY97 load at GS01. For subsequent water years, the Mower diversion structure has been upgraded and configured to prevent Woman Creek flows from entering the Mower Ditch.

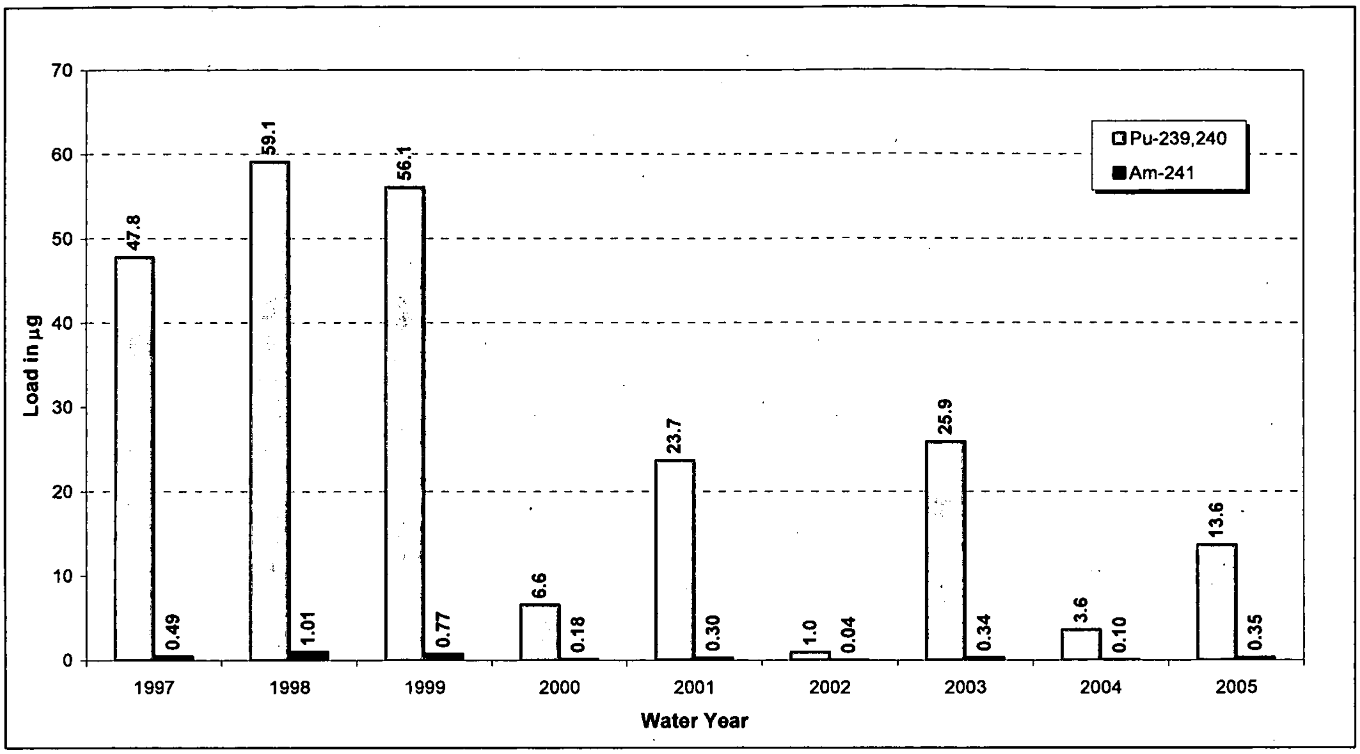


Figure 5-21. Annual Pu and Am Loads at GS01: WY97–05.

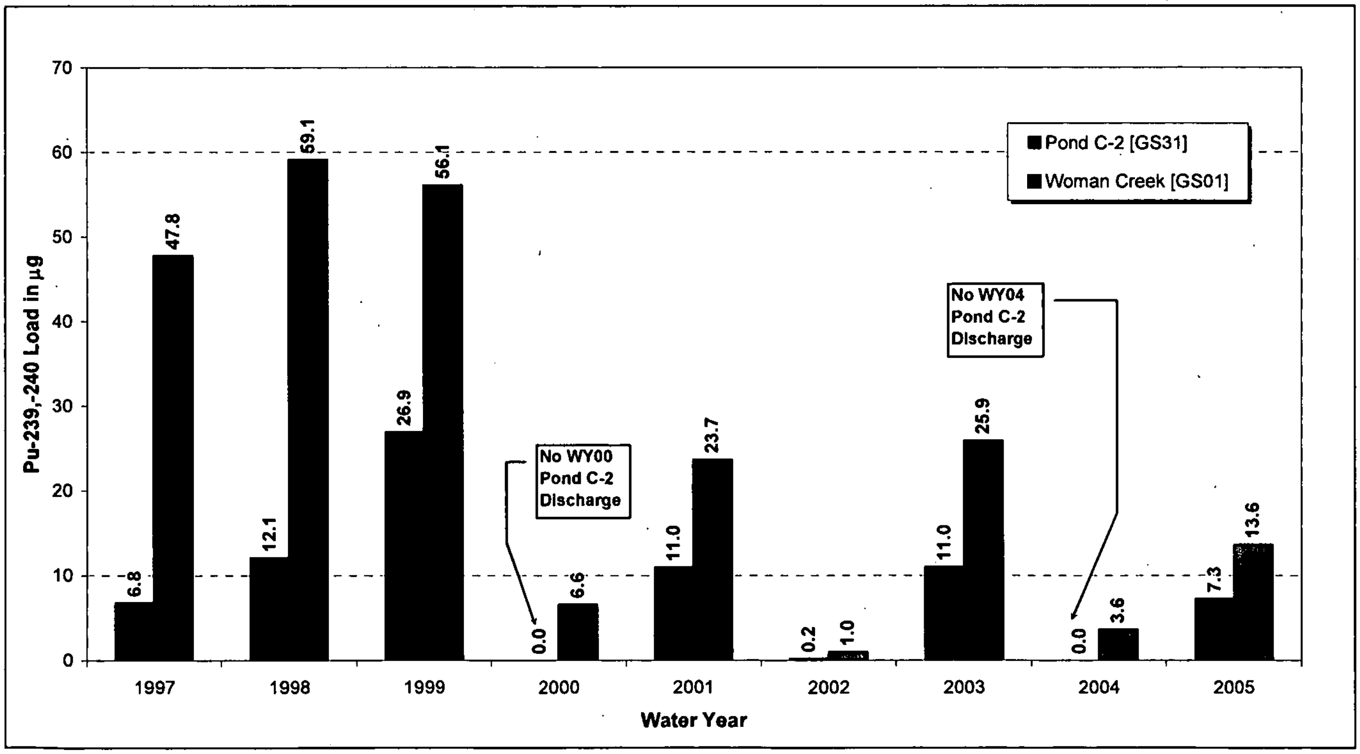


Figure 5-22. Annual Pu Loads at GS01 and GS31: WY97–05.

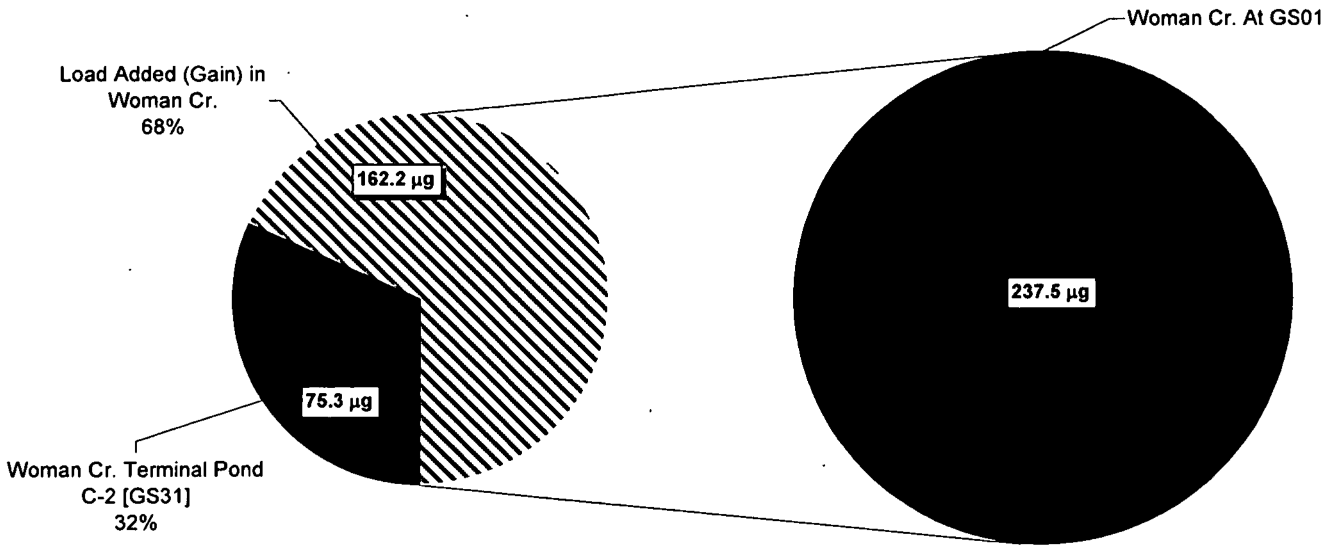


Figure 5-23. Relative Pu Load Totals at GS01 and GS31: WY97–05.

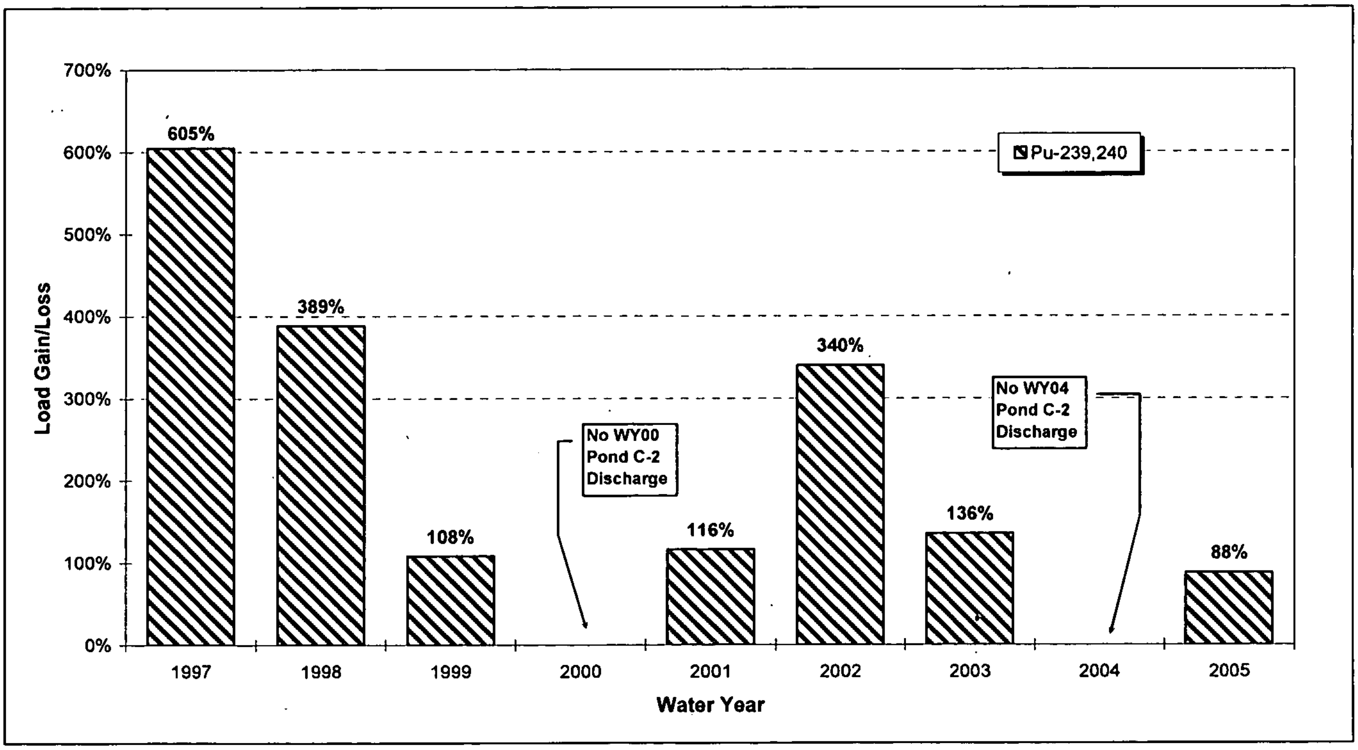


Figure 5-24. Annual Pu Load Gain/Loss for Woman Creek: WY97–05.

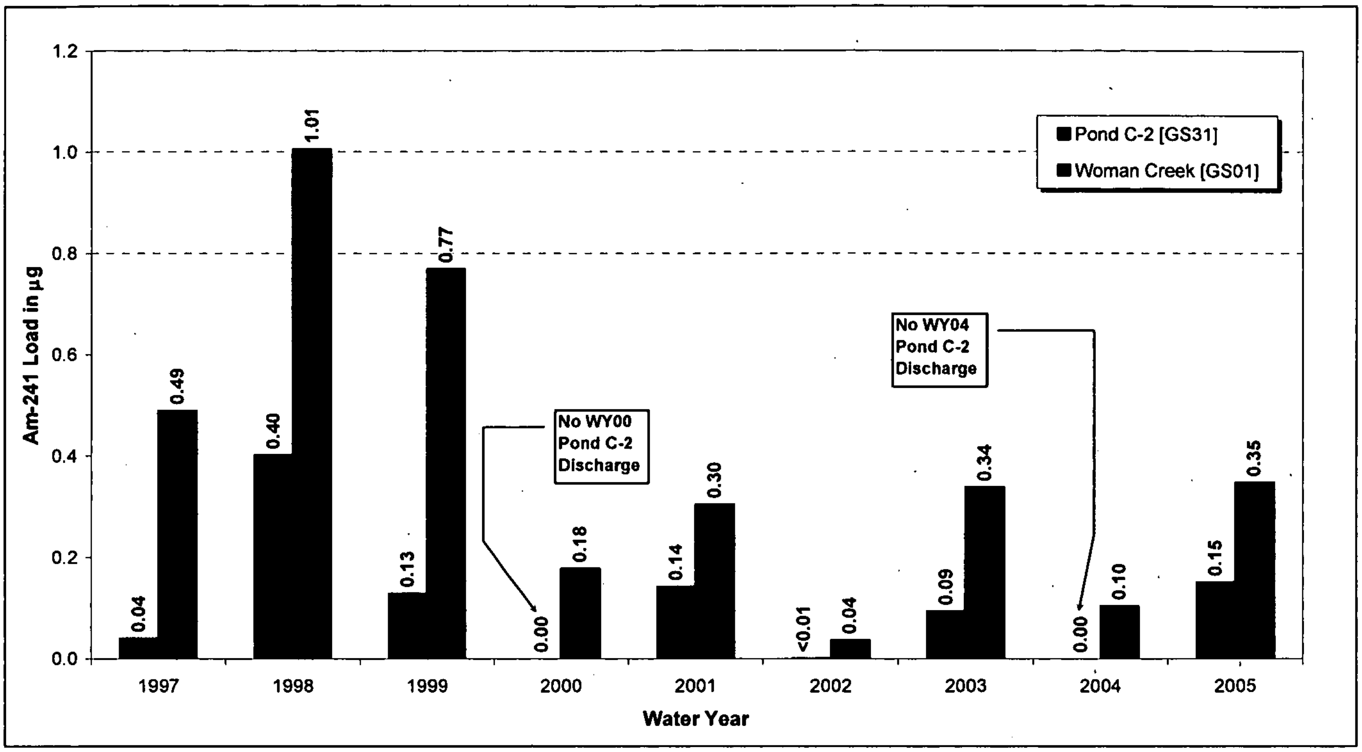


Figure 5-25. Annual Am Loads at GS01 and GS31: WY97–05.

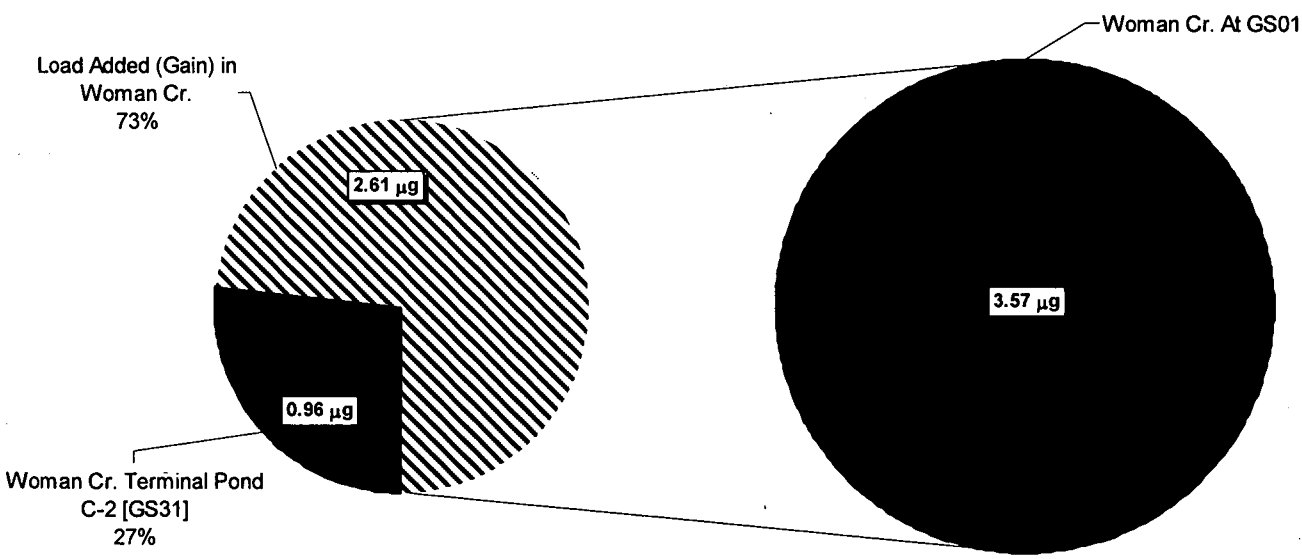


Figure 5-26. Relative Am Load Totals at GS01 and GS31: WY97–05.

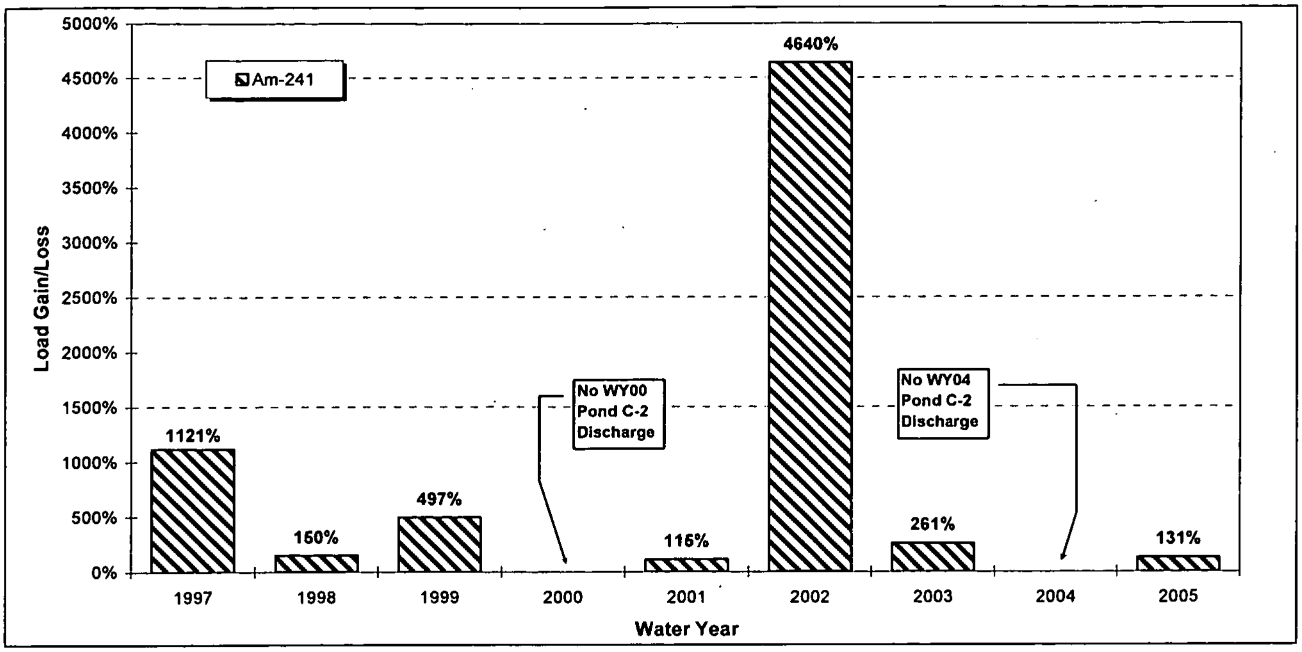


Figure 5-27. Annual Am Load Gain/Loss for Woman Creek: WY97–05.

Table 5-9. Total Uranium Loads at GS01 and GS31: WY03-05.

	Total Uranium (g)		
Water Year	**Pond C-2 [GS31]**	**POC GS01**	**Percent Gain/Loss**
2003	129	788	512%
2004	0.0; No C-2 Discharge	333	NA
2005	207	1351	553%
Total	336	2472	636%

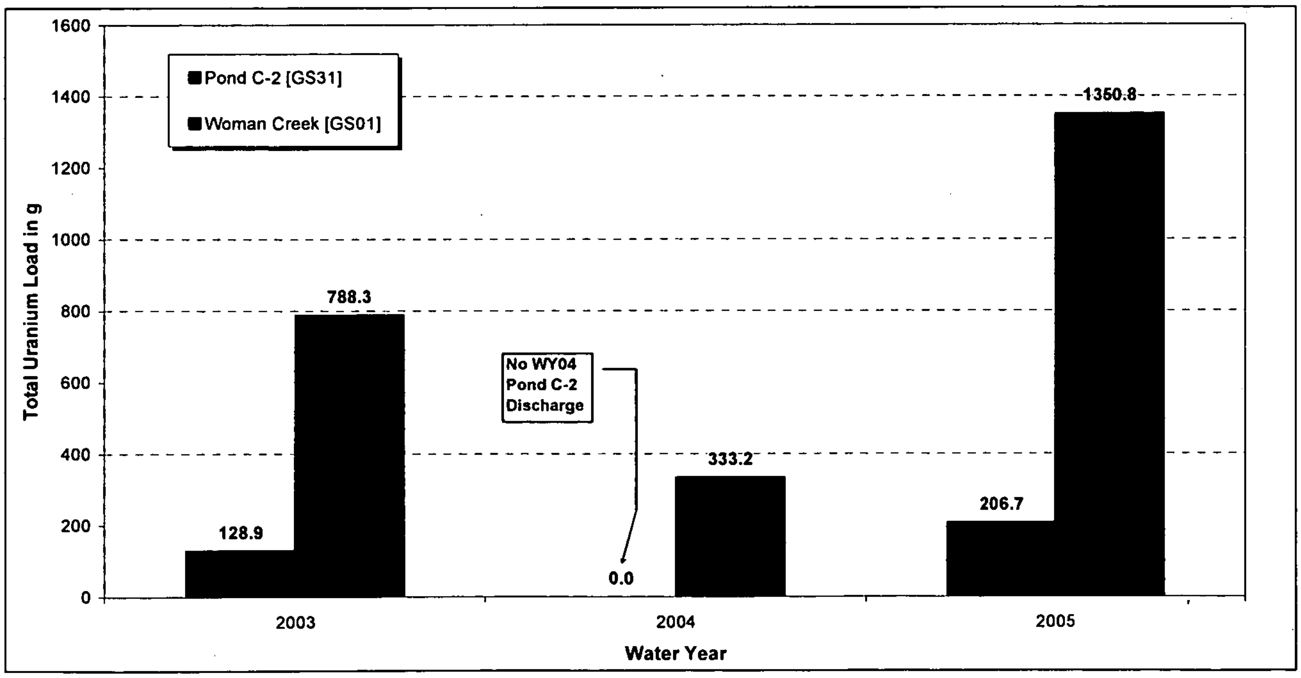


Figure 5-28. Annual Total Uranium Loads at GS01 and GS31: WY03-05.

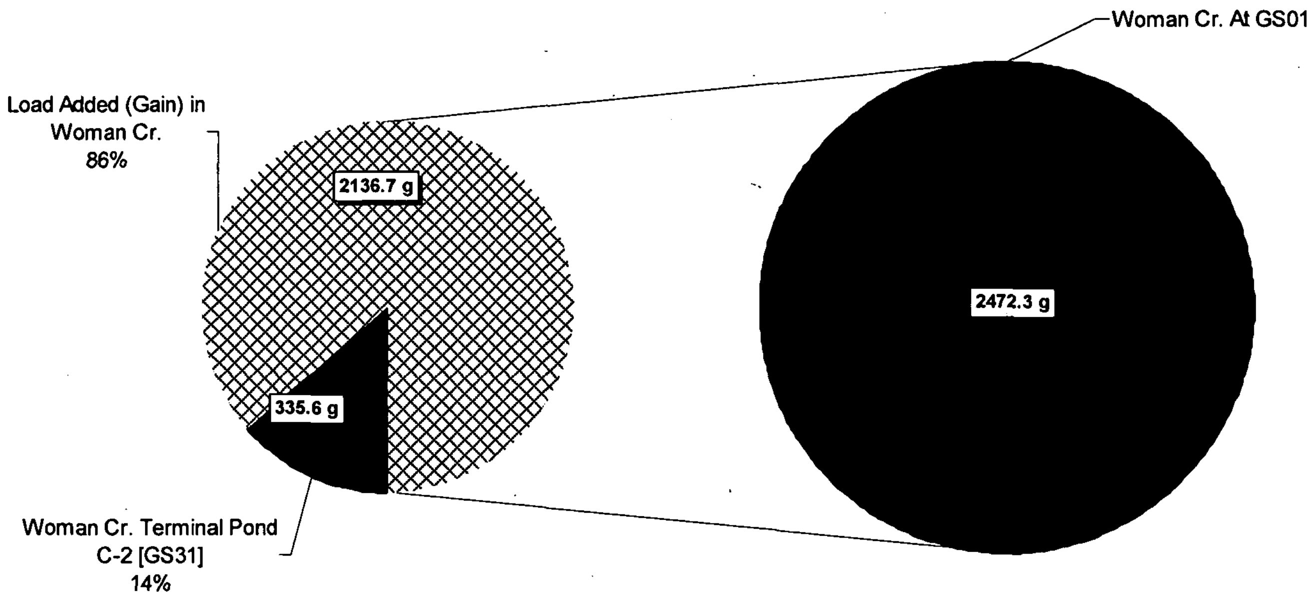


Figure 5-29. Relative Total Uranium Load Totals at GS01 and GS31: WY03-05.

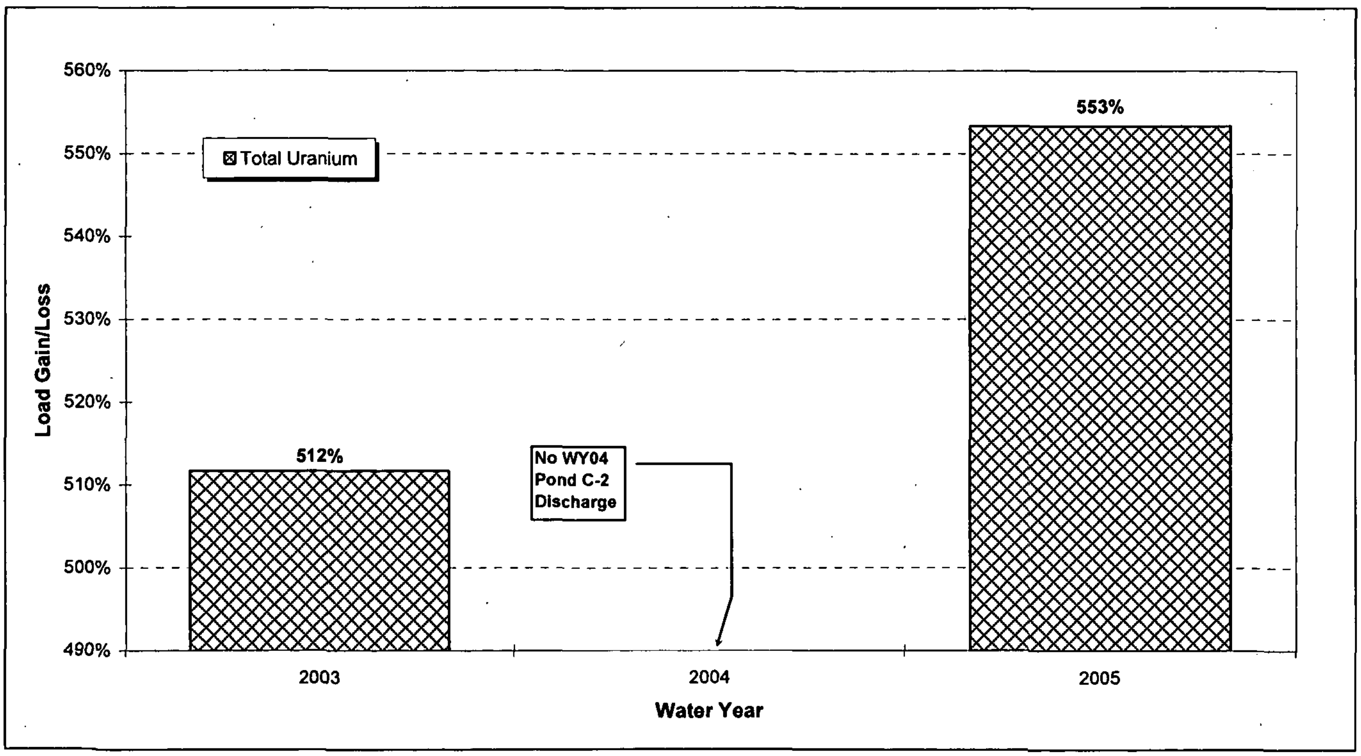


Figure 5-30. Annual Total Uranium Load Gain/Loss for Woman Creek: WY03–05.

5.5 TERMINAL RETENTION PONDS

This section summarizes the calculated Pu, Am, and total uranium loads from terminal ponds A-4, B-5, and C-2. The following points are noted:

- Annual Pu and Am loads vary significantly year-to-year (Figure 5-31 and Figure 5-33).
- A general reduction in Pu and Am loads is noted (Figure 5-31 and Figure 5-33).
- Pond B-5 accounts for a majority (77%) of the Pu load from the Site terminal ponds (Figure 5-32).
- Pond B-5 accounts for a majority (67%) of the Am load from the Site terminal ponds (Figure 5-34).
- Pond A-4 accounts for a majority (47%) of the total uranium loads from the Site terminal ponds (Figure 5-36).

Table 5-10. Pu and Am Loads from Terminal Ponds A-4, B-5, and C-2: WY97–05.

	Pu-239,240 (μg)			Am-241 (μg)		
Water Year	**Pond A-4 [GS11]**	**Pond B-5 [GS08]**	**Pond C-2 [GS31]**	**Pond A-4 [GS11]**	**Pond B-5 [GS08]**	**Pond C-2 [GS31]**
1997	46.0	13.7	6.8	0.52	0.27	0.04
1998	30.7	22.4	12.1	1.33	0.40	0.40
1999	27.0	255.9	26.9	0.35	1.73	0.13
2000	27.9	245.3	0.0; No C-2 Discharge	0.02	3.16	0.00; No C-2 Discharge
2001	5.3	32.0	11.0	0.11	0.46	0.14
2002	0.1	12.9	0.2	0.02	0.27	0.00
2003	5.4	111.5	11.0	0.20	0.45	0.09
2004	4.1	26.2	0.0; No C-2 Discharge	0.14	0.72	0.0; No C-2 Discharge
2005	2.2	18.8	7.3	0.43	0.98	0.15
Total	148.6	738.8	75.3	3.12	8.42	0.96

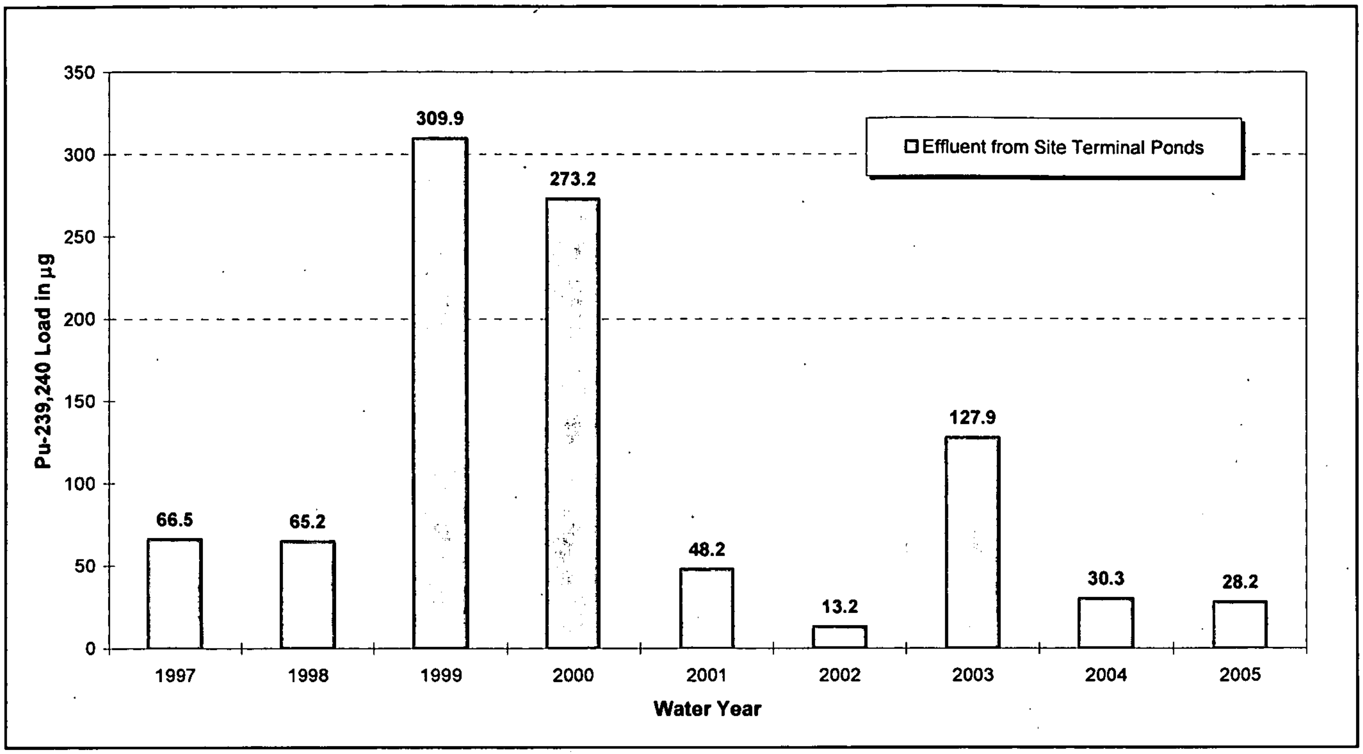


Figure 5-31. Annual Pu Loads from Terminal Ponds A-4, B-5, and C-2: WY97–05.

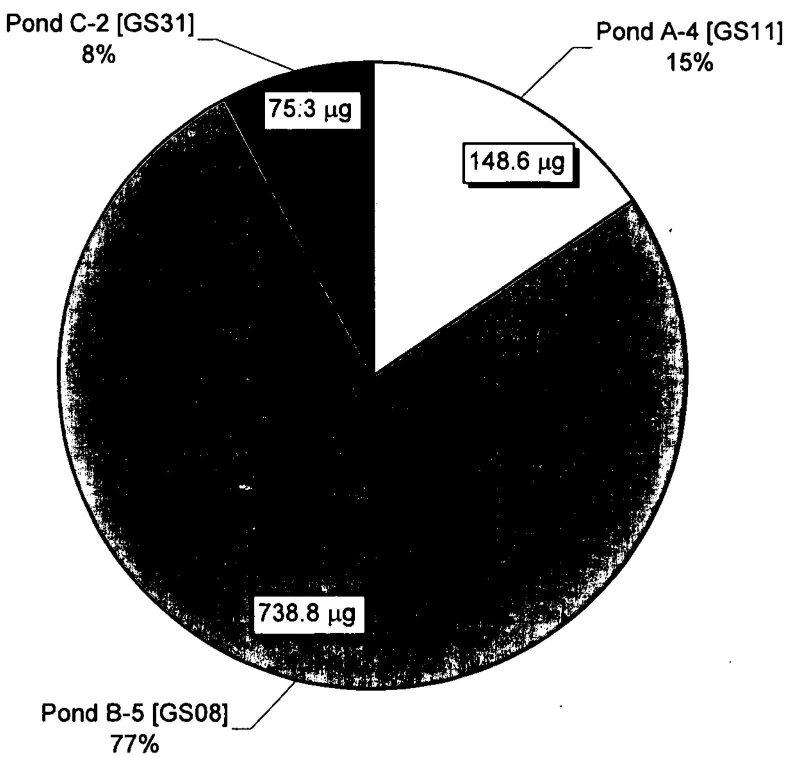


Figure 5-32. Relative Pu Load Totals from Terminal Ponds A-4, B-5, and C-2: WY97–05.

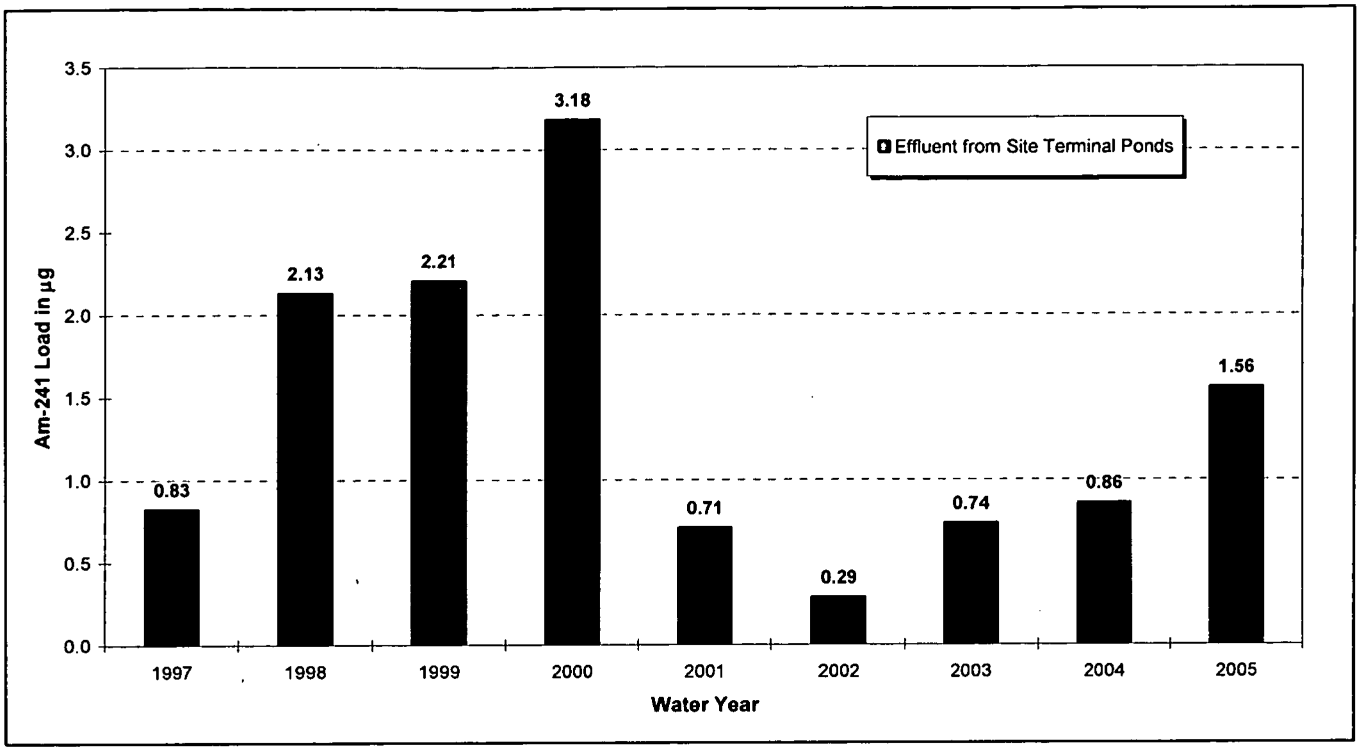


Figure 5-33. Annual Am Loads from Terminal Ponds A-4, B-5, and C-2: WY97–05.

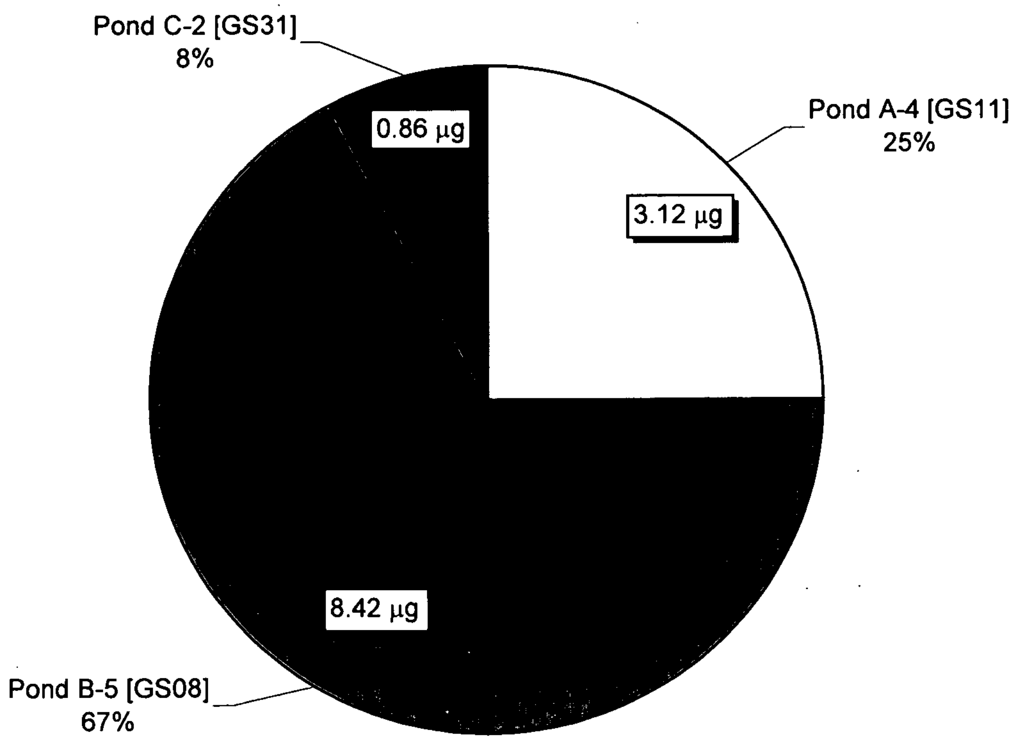


Figure 5-34. Relative Am Load Totals from Terminal Ponds A-4, B-5, and C-2: WY97–05.

Table 5-11. Total Uranium Loads from Terminal Ponds A-4, B-5, and C-2: WY97–05.

	Total Uranium (g)		
Water Year	**Pond A-4 [GS11]**	**Pond B-5 [GS08]**	**Pond C-2 [GS31]**
1997	1014	327	103
1998	1611	653	343
1999	768	631	189
2000	312	587	0.000; No C-2 Discharge
2001	638	574	67
2002	93	345	1
2003	855	595	129
2004	364	418	0.000; No C-2 Discharge
2005	165	1411	207
Total	5821	5540	1039

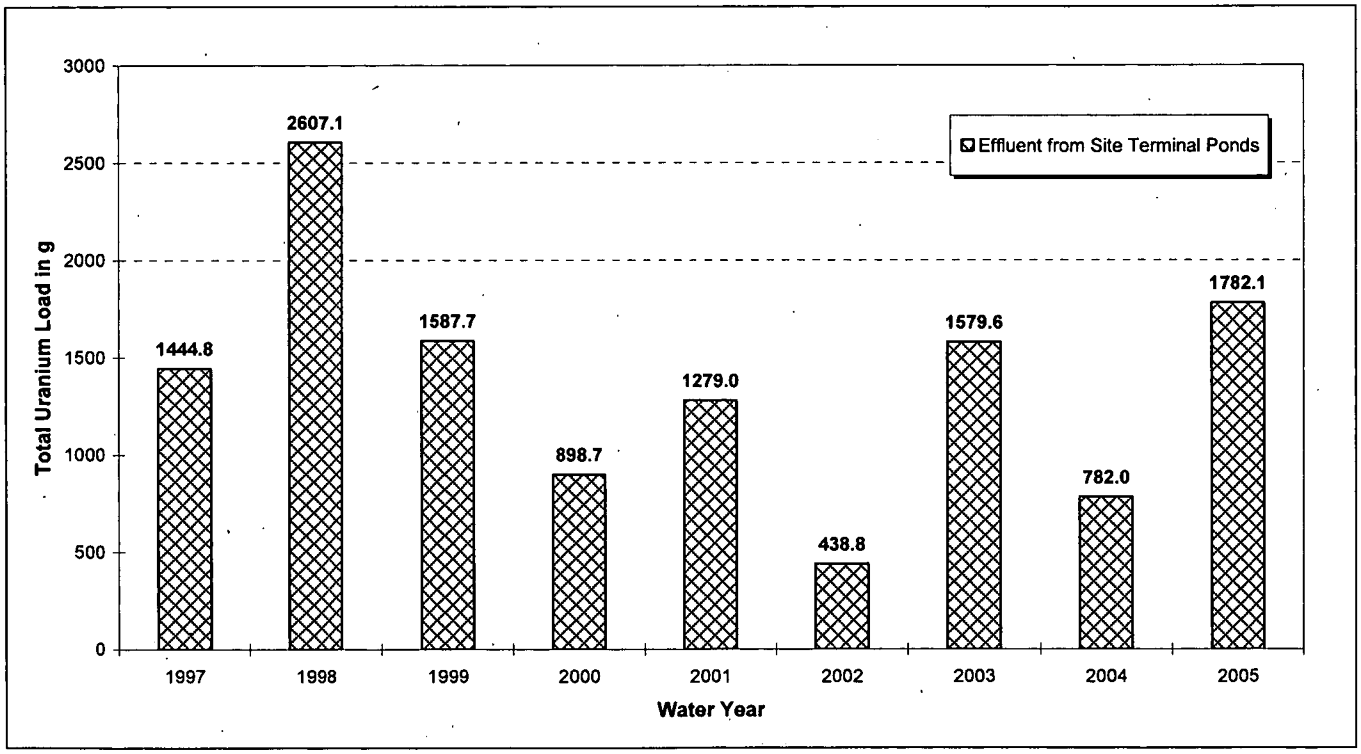


Figure 5-35. Annual Total Uranium Loads from Terminal Ponds A-4, B-5, and C-2: WY97–05.

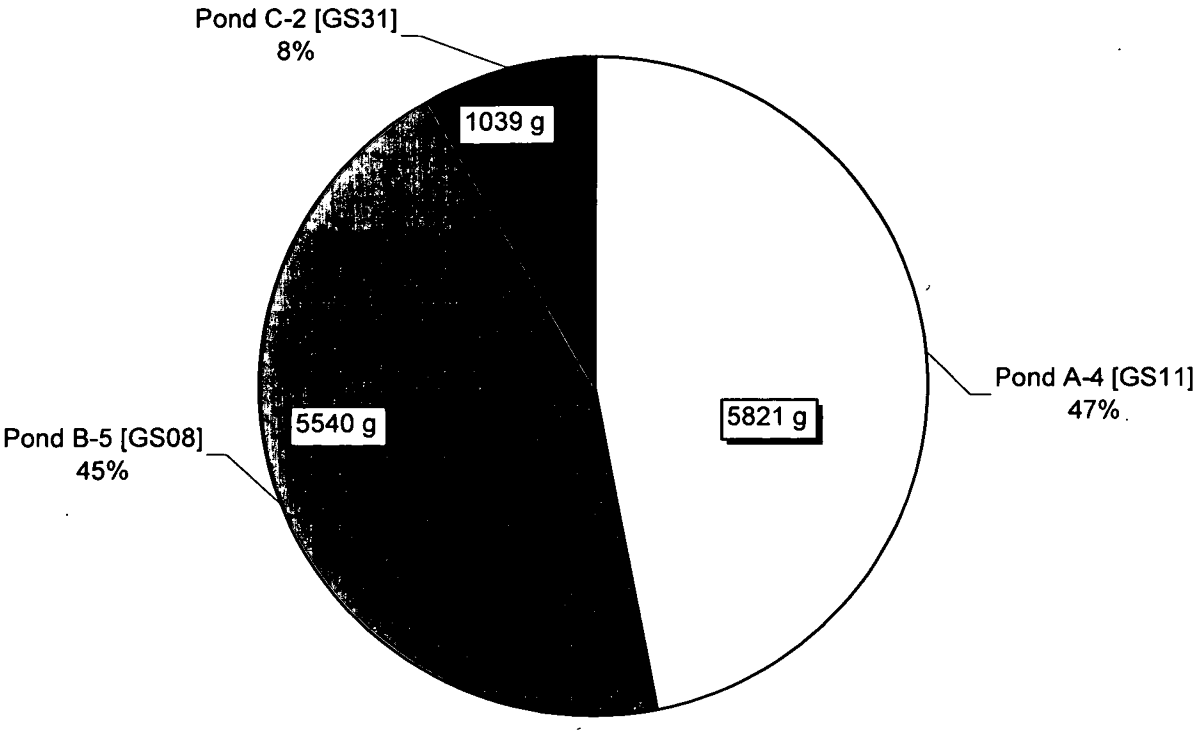


Figure 5-36. Relative Total Uranium Load from Terminal Ponds A-4, B-5, and C-2: WY97–05.

5.5.1 A- and B-Series Ponds (POCs GS08 and GS11)

This section summarizes the calculated Pu, Am, and total uranium loads for the A- and B-Series Ponds. Since water transfers occur between ponds, the load analysis below is performed for both pond series combined. The influent load sources are GS10 and the WWTP (South Walnut), and SW093 (North Walnut). The effluent loads are GS08 (Pond B-5 outlet) and GS11 (Pond A-4 outlet). The following points are noted:

- Total Pu load removal by Pond A-4 and B-5 is calculated as 82% (Table 5-12; Figure 5-38).
- Figure 5-58 shows GS10 with the highest influent Pu load.
- A significant increase in Pu loads to the ponds is noted during WY04 due to increased solids transport resulting from active building demolition and soil disturbance (Figure 5-37). With the enhanced implementation of erosion controls, revegetation, and soil stabilization, a significant reduction is noted for WY05.
- Total Am load removal by Pond A-4 and B-5 is calculated as 89% (Table 5-13; Figure 5-41). A portion of the Am load removal from Pond A-4 is due to active treatment of A-4 water during WY05.
- Figure 5-60 shows GS10 with the highest influent Am load.
- A measurable increase in Am loads to the ponds is noted during both WY04 and WY05. These increases were partly due to increased solids transport resulting from active building demolition and soil disturbance (Figure 5-40). Increased Am loads at SW093 were primarily due to contributions from B771 D&D during the July 2004 through November 2004 period (WY04-05). The pathway causing these increased loads was eliminated in December 2004.
- Annual Pu and Am loads vary significantly year-to-year (Figure 5-37 and Figure 5-40) depending on hydrologic and solids transport variations.

- Figure 5-43 shows GS10 with the highest influent total uranium activity, while SW093 shows the highest total uranium load (larger flow volumes at SW093).
- Figure 5-43 shows GS11 with the highest effluent total uranium activity and load.
- There is little total uranium load removal in Ponds A-4 and B-5. Some years show gains while others show losses (Figure 5-46). WY2002 shows abnormally high removal, possibly due to the drought conditions resulting in less groundwater flowing directly to the ponds downstream of the influent measurement points.

Table 5-12. Pu Load Summary for the A- and B-Series Ponds: WY97–05.

	Pu-239,240 (µg)					
Water Year	**Influent (WWTP)**	**Influent (GS10)**	**Influent (SW093)**	**Effluent (GS08)**	**Effluent (GS11)**	**Percent Removal**
1997	13.4	564.0	178.7	13.7	46.0	92%
1998	8.7	345.3	70.9	22.4	30.7	87%
1999	23.2	306.8	126.9	255.9	27.0	38%
2000	18.4	329.6	88.5	245.3	27.9	37%
2001	9.1	140.9	44.6	32.0	5.3	81%
2002	7.2	50.6	10.0	12.9	0.1	81%
2003	6.2	212.4	138.7	111.5	5.4	67%
2004	2.9	520.9	1301.9	26.2	4.1	98%
2005	0.0	255.6	59.9	18.8	2.2	93%
Total	89.1	2726.2	2020.0	738.8	148.6	82%

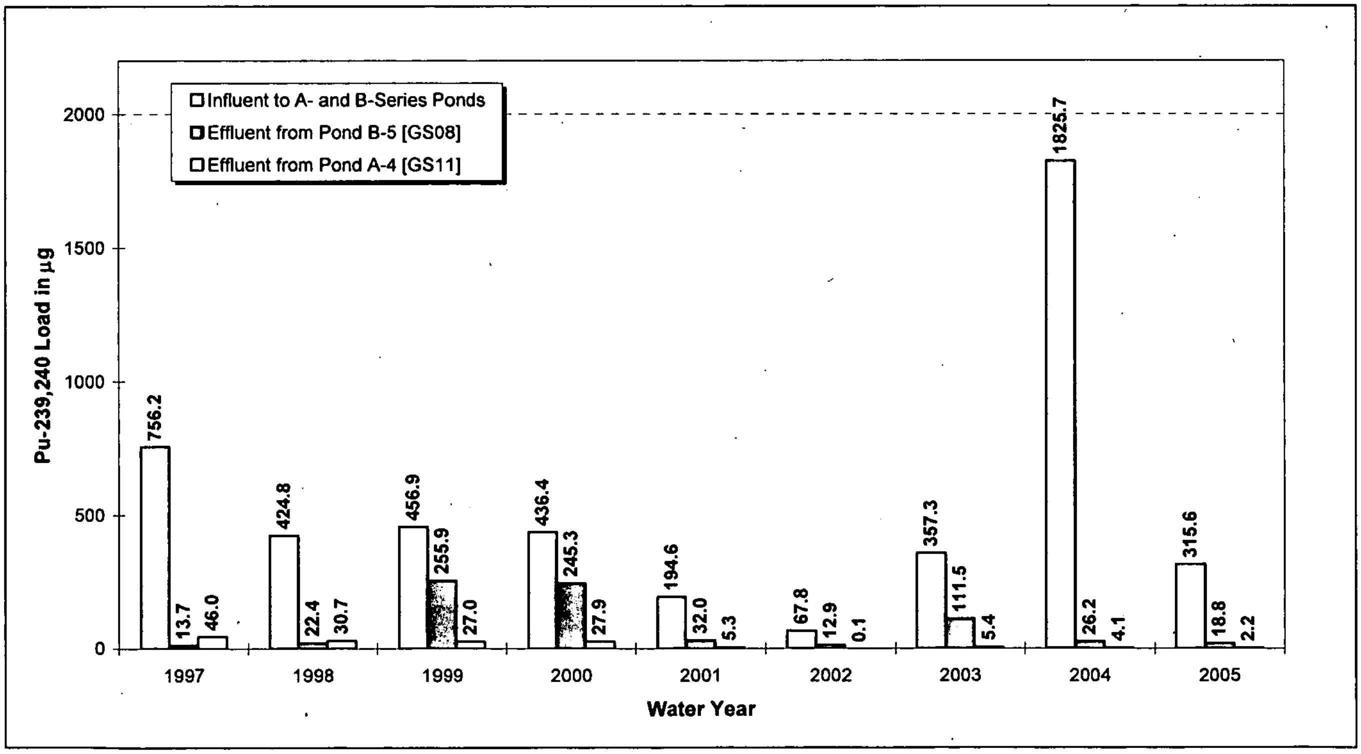


Figure 5-37. Annual Pu Loads for the A- and B-Series Ponds: WY97–05.

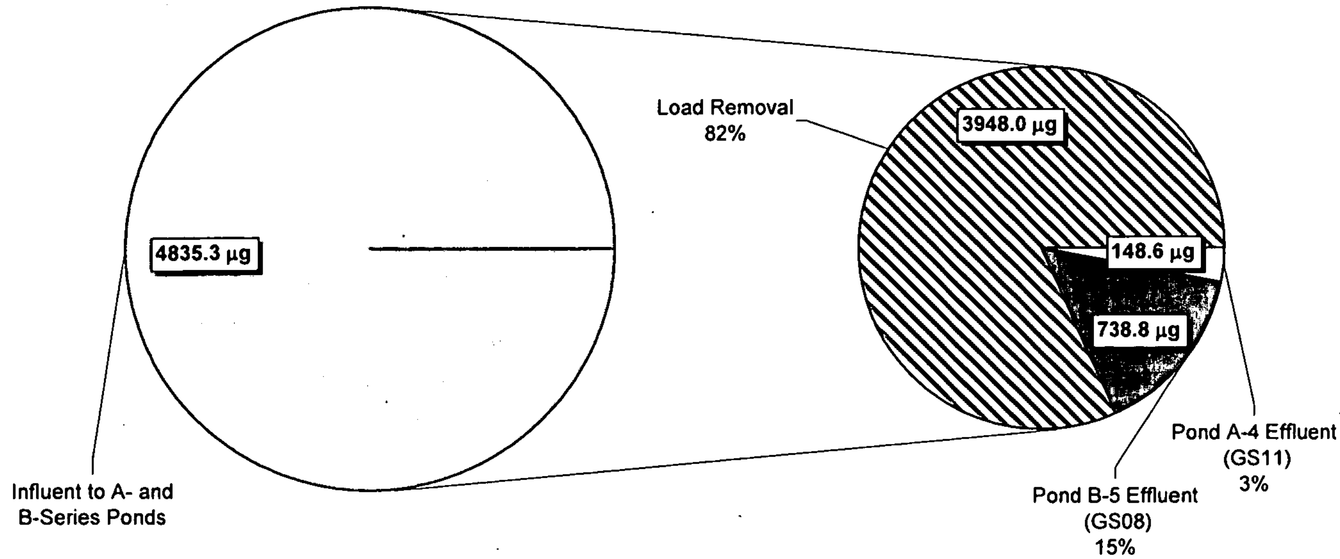


Figure 5-38. Relative Pu Load Totals for the A- and B-Series Terminal Ponds: WY97–05.

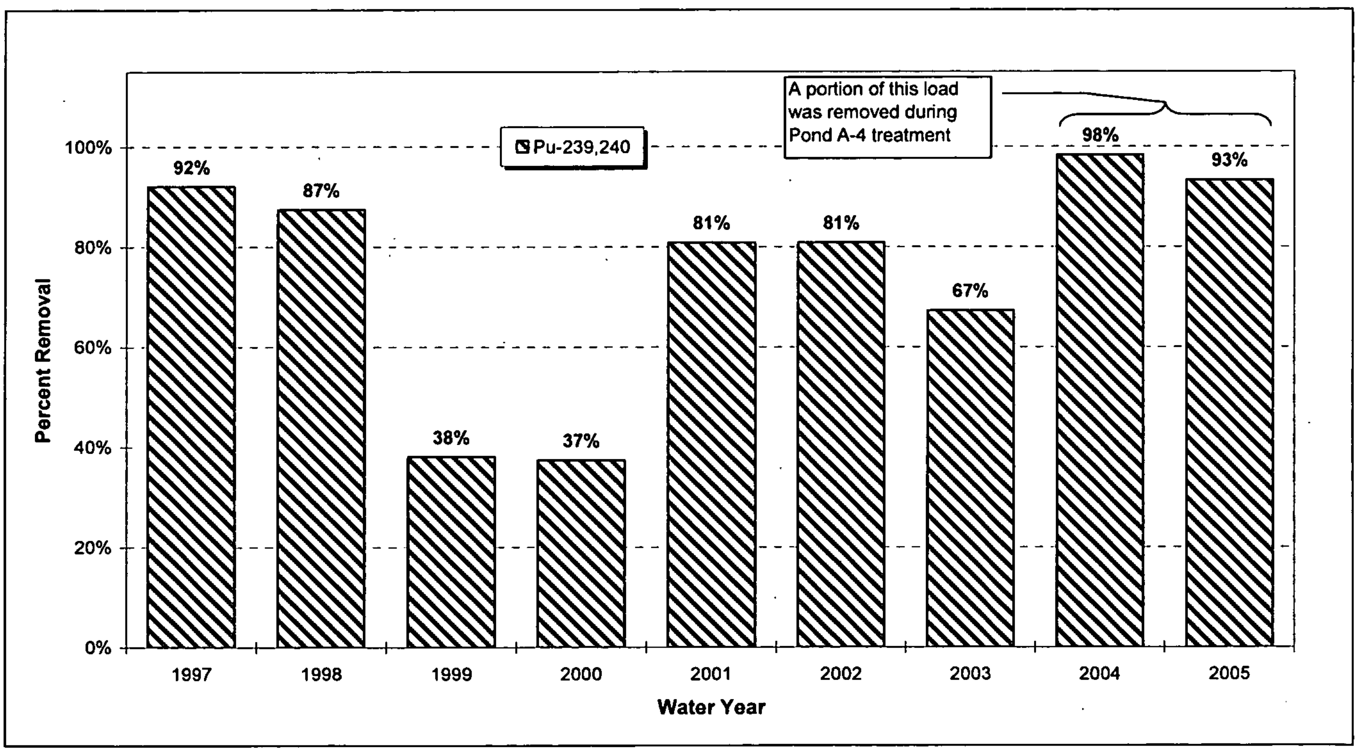


Figure 5-39. Annual Pu Load Removal for the A- and B-Series Ponds: WY97–05.

Table 5-13. Am Load Summary for the A- and B-Series Ponds: WY97–05.

	Am-241 (µg)					
Water Year	**Influent (WWTP)**	**Influent (GS10)**	**Influent (SW093)**	**Effluent (GS08)**	**Effluent (GS11)**	**Percent Removal**
1997	0.44	11.98	2.27	0.27	0.52	95%
1998	0.58	4.95	1.38	0.40	1.33	75%
1999	0.11	12.55	1.69	1.73	0.35	86%
2000	0.33	14.65	1.03	3.16	0.02	80%
2001	0.26	2.71	0.65	0.46	0.11	84%
2002	0.23	1.64	0.50	0.27	0.02	88%
2003	0.22	4.43	2.06	0.45	0.20	90%
2004	0.59	4.42	14.36	0.72	0.14	96%
2005	0.00	4.47	14.94	0.98	0.43	93%
Total	2.75	61.80	38.88	8.42	3.12	89%

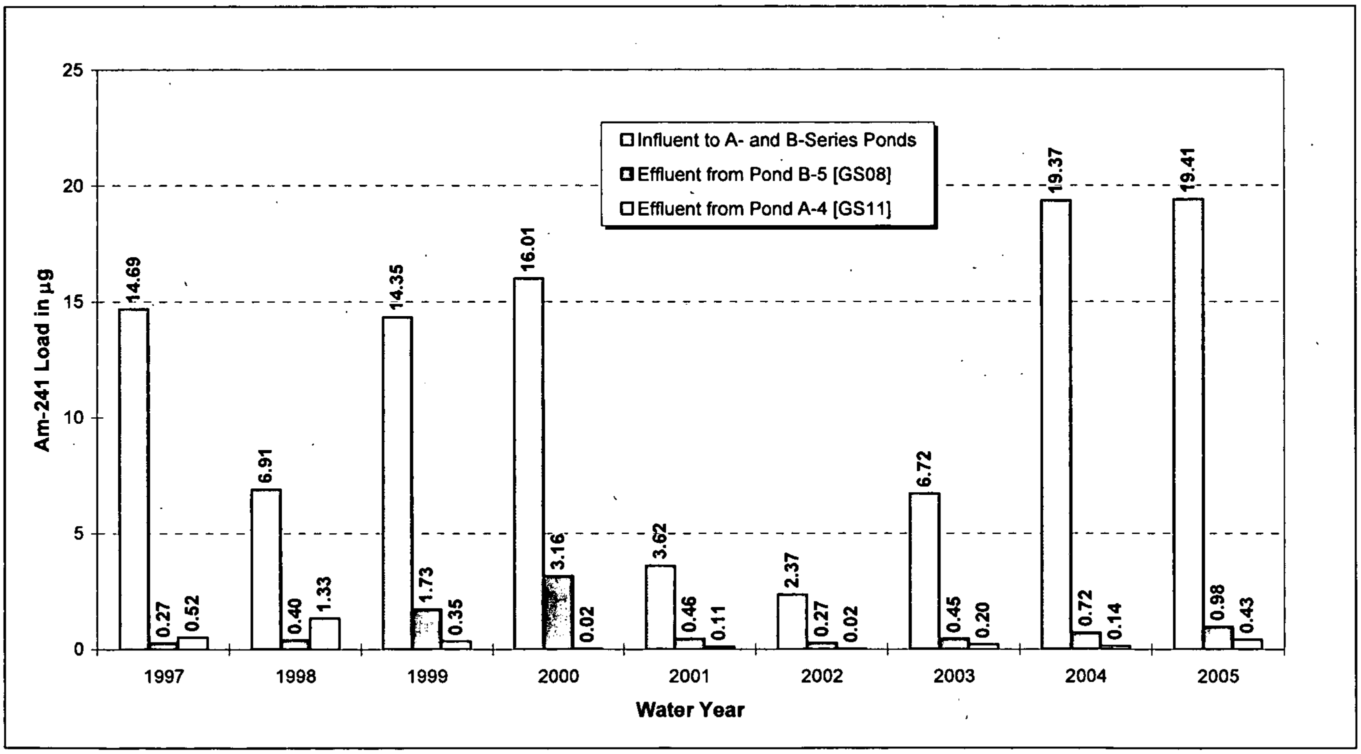


Figure 5-40. Annual Am Loads for the A- and B-Series Ponds: WY97–05.

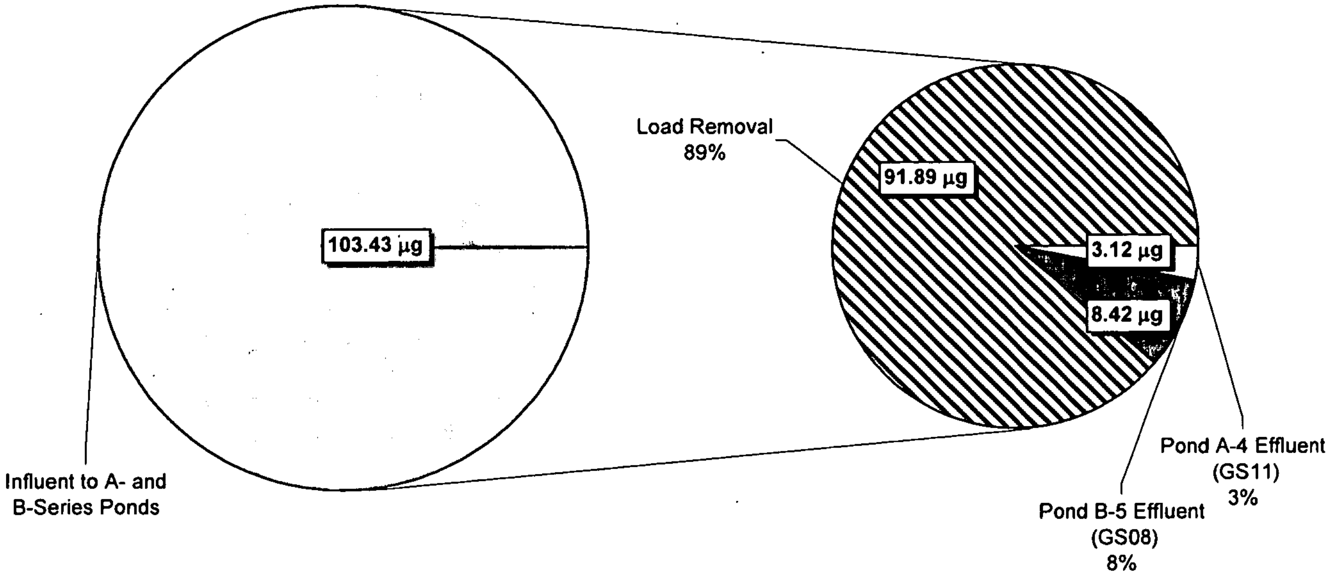


Figure 5-41. Relative Am Load Totals for the A- and B-Series Ponds: WY97–05.

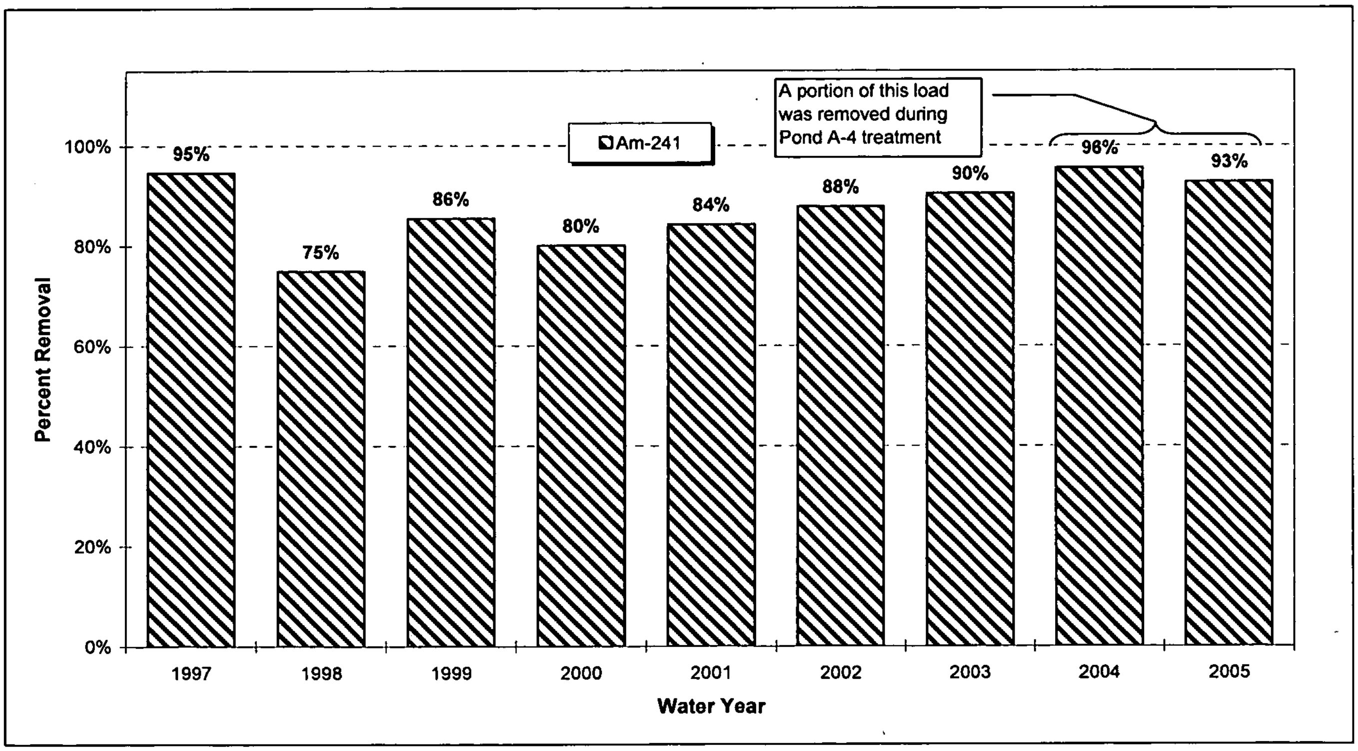
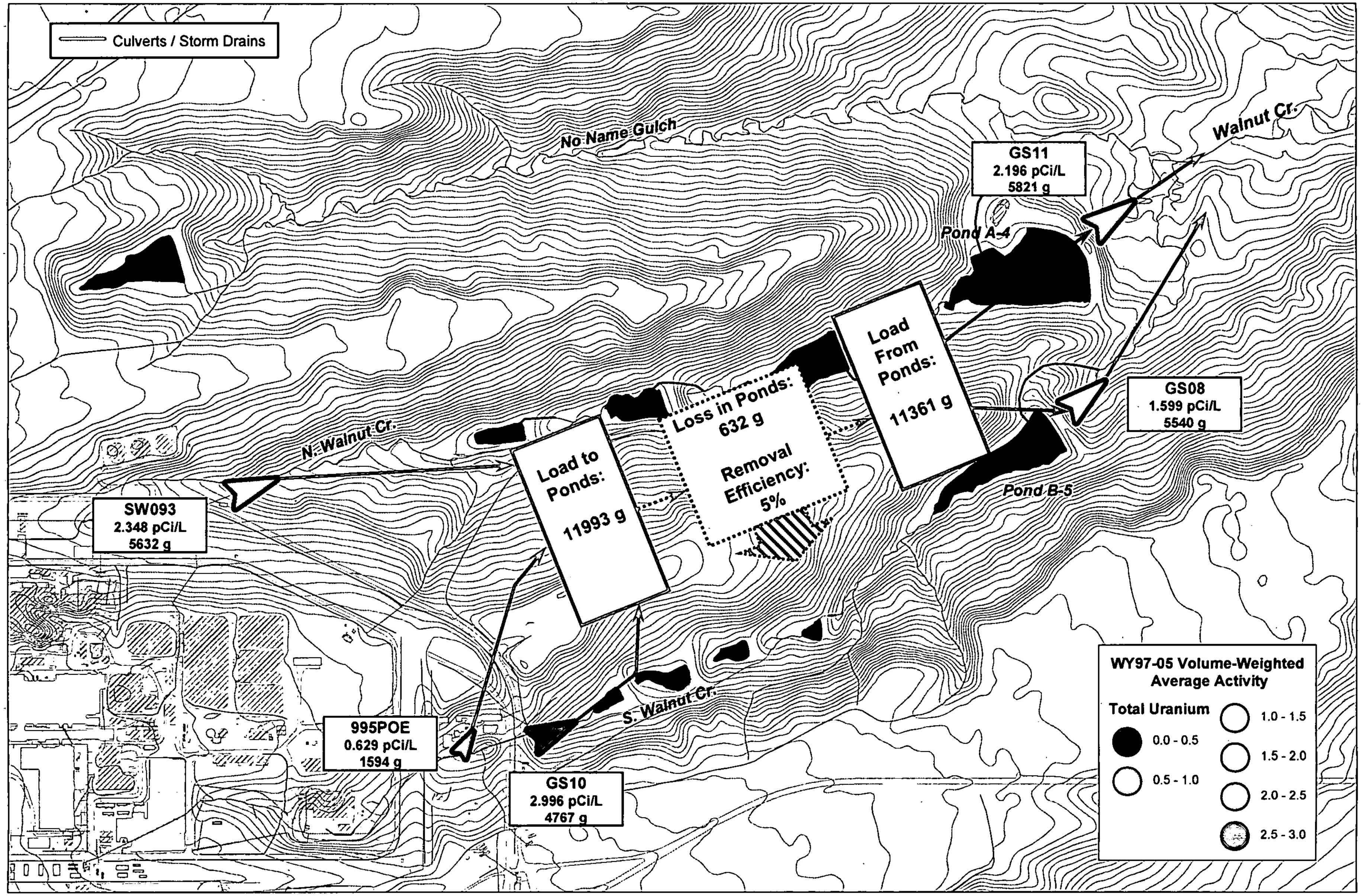


Figure 5-42. Annual Am Load Removal for the A- and B-Series Ponds: WY97–05.



Note: Location symbols are displayed proportional to calculated load and shaded according to activity ranges in legend.

Figure 5-43. Relative Total Uranium Loading Schematic for the A- and B-Series Ponds: WY97-05.

Table 5-14. Total Uranium Load Summary for the A- and B-Series Ponds: WY97–05

	Total Uranium (g)					
Water Year	**Influent (WWTP)**	**Influent (GS10)**	**Influent (SW093)**	**Effluent (GS08)**	**Effluent (GS11)**	**Percent Removal**
1997	218	560	783	327	1014	14%
1998	516	683	881	653	1611	-9%
1999	108	577	680	631	768	-2%
2000	110	399	534	587	312	14%
2001	254	518	641	574	638	14%
2002	75	288	439	345	93	45%
2003	161	516	663	595	855	-8%
2004	146	360	441	418	364	17%
2005	7	865	569	1411	165	-9%
Total	1594	4767	5632	5540	5821	5%

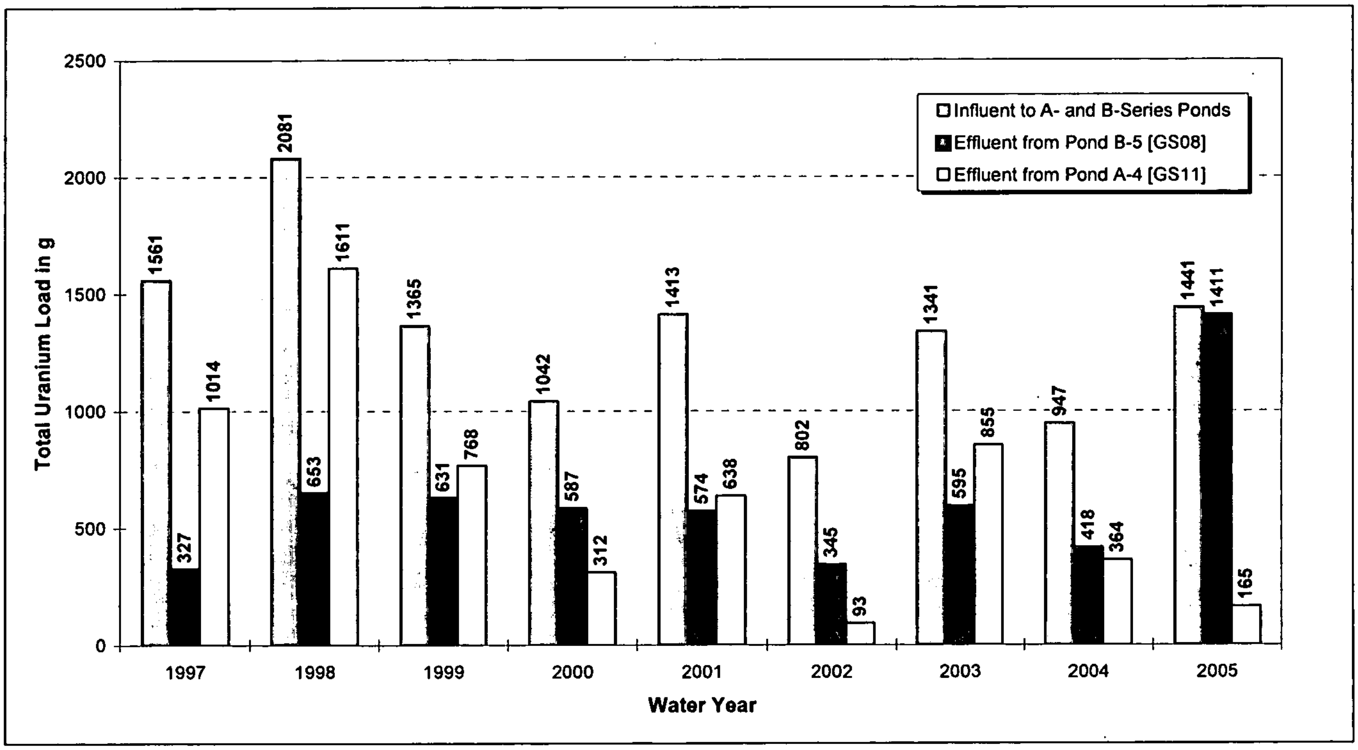


Figure 5-44. Annual Total Uranium Loads for the A- and B-Series Ponds: WY97–05.

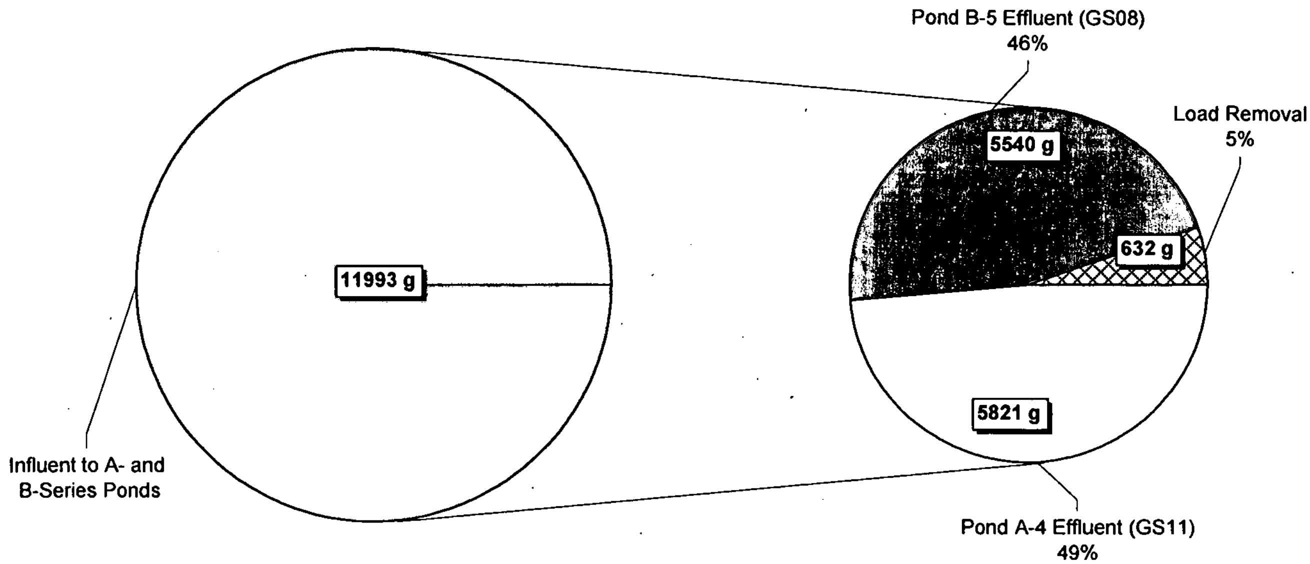


Figure 5-45. Relative Total Uranium Load Totals for the A- and B-Series Ponds: WY97–05.

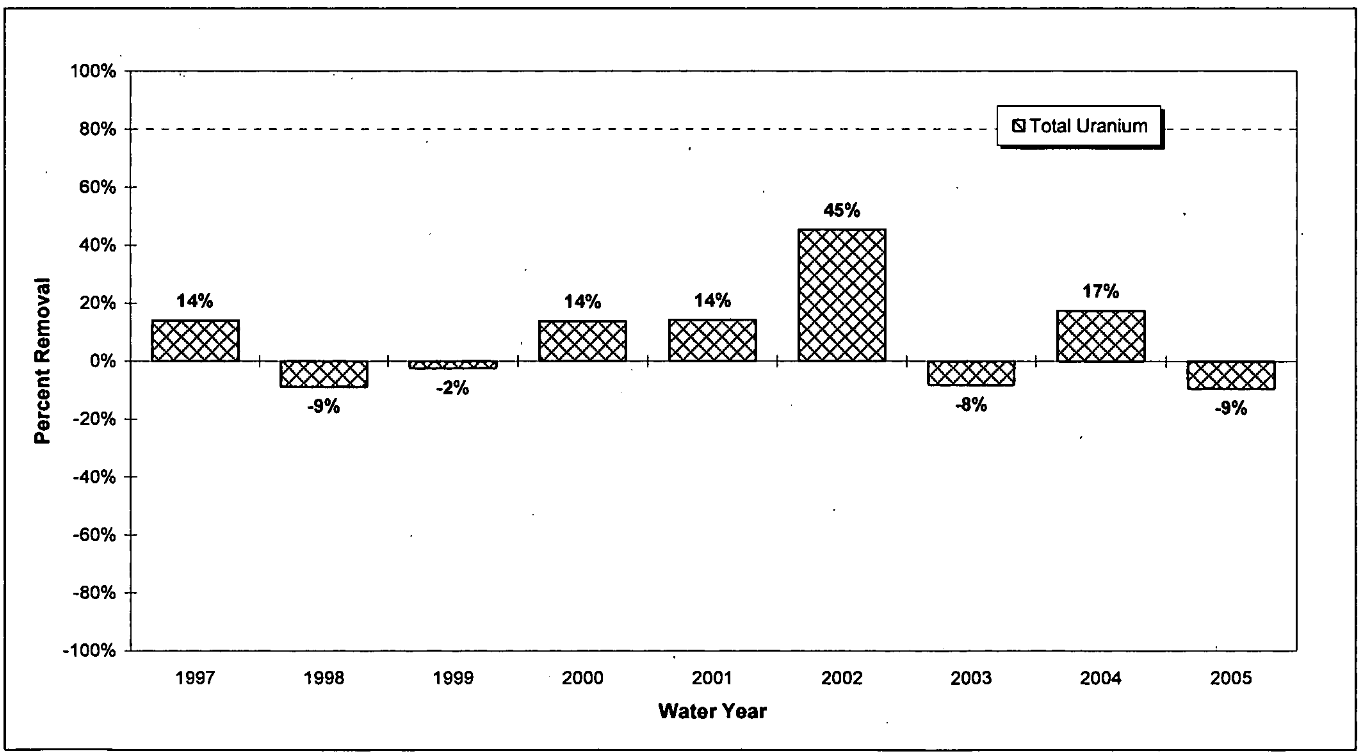


Figure 5-46. Annual Total Uranium Load Removal for the A- and B-Series Ponds: WY97–05.

5.5.2 Pond C-2 (POC GS31)

This section summarizes the calculated Pu, Am, and total uranium loads for Pond C-2. The influent load source is SW027 (SID at Pond C-2 inlet).[29] The effluent loads are calculated at GS31 (Pond C-2 outlet). The following points are noted:

- Total Pu load removal by Pond C-2 is calculated as 93% (Table 5-15; Figure 5-48).
- Total Am load removal by Pond C-2 is calculated as 77% (Table 5-16; Figure 5-51).
- WY98, WY01, and WY05 show that Am load from Pond C-2 exceeded inflow load. Similarly, for WY01 and WY02 Pu load from Pond C-2 exceeded inflow load. This lack of removal is likely due to samples collected during pond dewatering to allow for video surveillance of the outlet works, routine valve tests, and outlet works upgrades. During these types of operations, the outlet works valve on the bottom (essentially in the pond bottom sediments) of the pond is used to drain the pond. At these low pond levels, higher TSS values were observed. Since Pu and Am are transported with particulate matter, the higher activities and loads are expected.
- Annual Pu and Am loads vary significantly year-to-year (Figure 5-47 and Figure 5-50). A significant increase in both Pu and Am loads to C-2 is noted during WY04 due to increased solids transport from extensive soil disturbance in the drainage associated with the 903 Pad/Lip project. With the enhanced implementation of erosion controls, revegetation, and soil stabilization, a significant reduction is noted for WY05.
- Annual total uranium loads also vary significantly year-to-year (Figure 5-54).
- There is significant total uranium load gain in Pond C-2. This may be caused by groundwater with naturally occurring uranium entering Pond C-2 downstream of SW027 (Figure 5-55). WY2002 shows abnormally high removal, possibly due to the drought conditions resulting in less groundwater flowing to the pond downstream of SW027.

Table 5-15. Pu Load Summary for Terminal Pond C-2: WY97–05.

	Pu-239,240 (μg)		
Water Year	**Influent (SW027)**	**Effluent (GS31)**	**Percent Removal**
1997	14.2	6.8	52%
1998	90.8	12.1	87%
1999	34.1	26.9	21%
2000	67.5	0.0; No C-2 Discharge	No C-2 Discharge
2001	10.7	11.0	-3%
2002	0.20	0.22	-9%
2003	45.2	11.0	76%
2004	815.7	0.0; No C-2 Discharge	No C-2 Discharge
2005	23.8	7.3	69%
Total	1102.1	75.3	93%

[29] As of the publication of this report, the composite sample at SW027 started on 5/18/05 was still in progress. SW027 has not flowed since 6/14/05 and the composite currently contains 2.2 liters, a non-sufficient quantity for analysis. Therefore, the activity for the period 5/18-10/1/05 was estimated as the volume-weighted activity for WY05 using the available data.

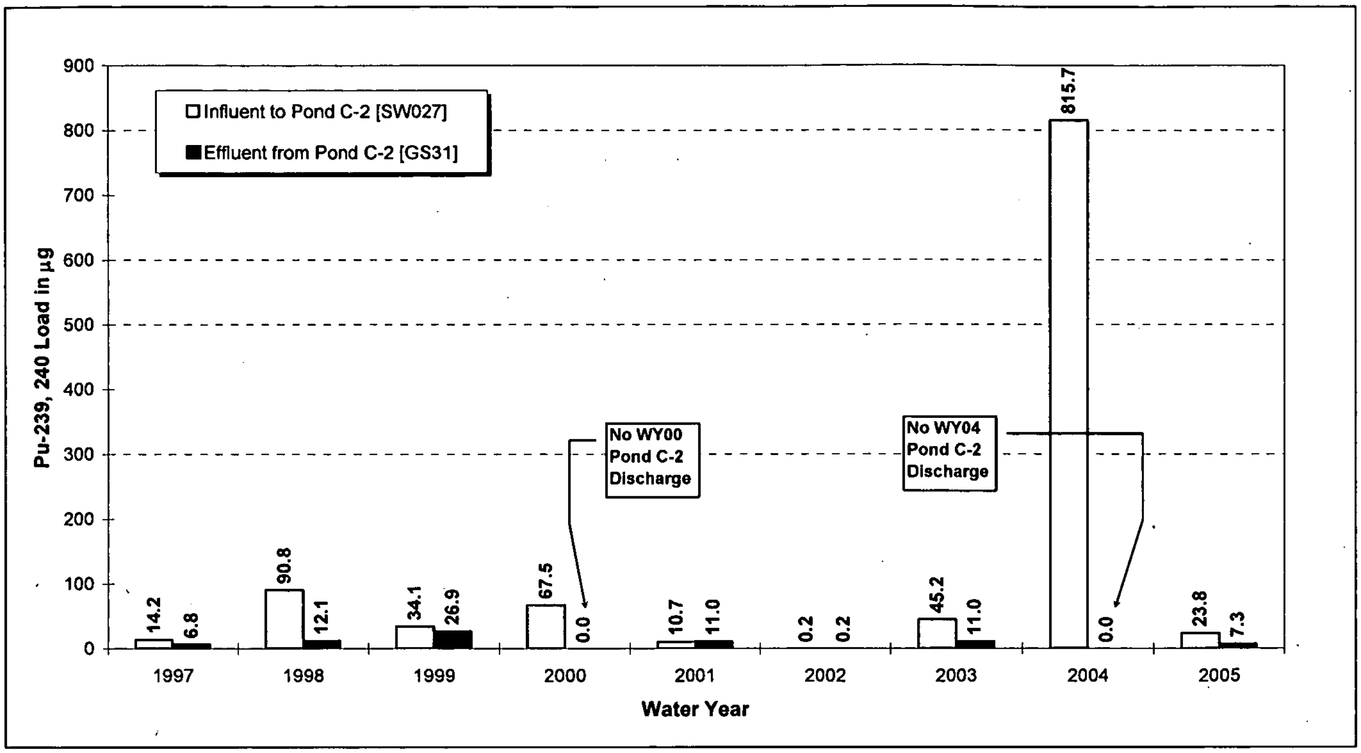


Figure 5-47. Annual Pu Loads for Pond C-2: WY97–05.

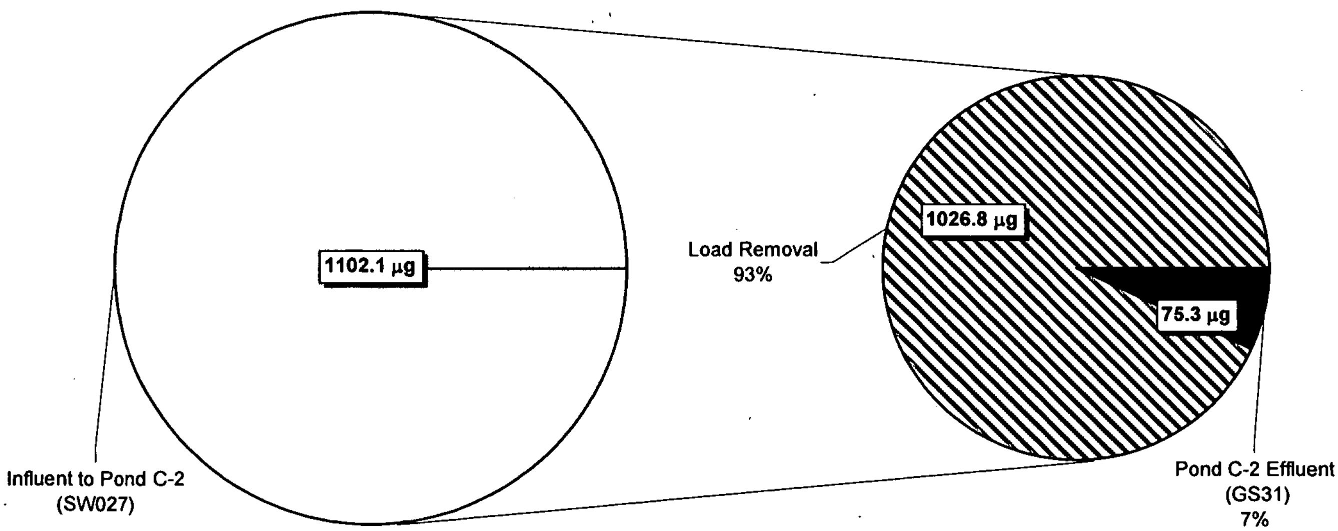


Figure 5-48. Relative Pu Load Totals for Pond C-2: WY97–05.

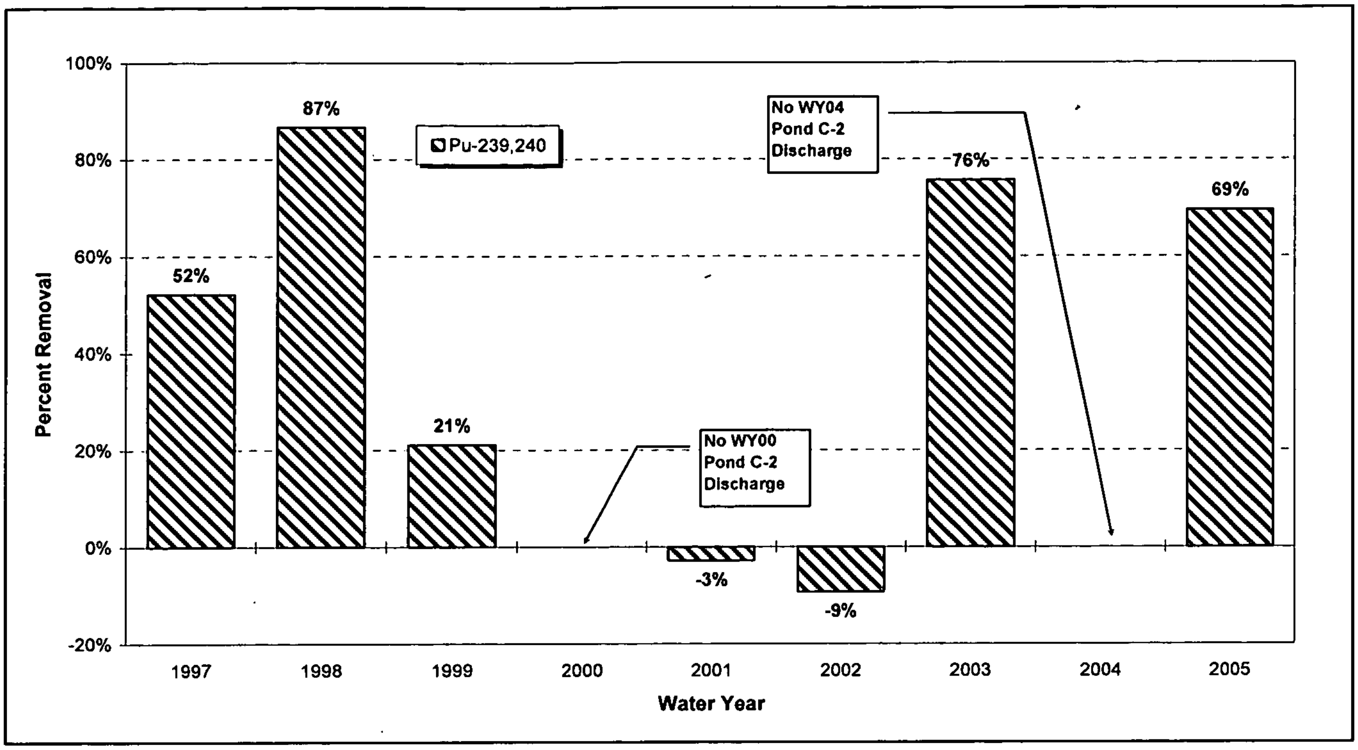


Figure 5-49. Annual Pu Load Removal for Pond C-2: WY97–05.

Table 5-16. Am Load Summary for Terminal Pond C-2: WY97–05.

	Am-241 (µg)		
Water Year	**Influent (SW027)**	**Effluent (GS31)**	**Percent Removal**
1997	0.06	0.04	27%
1998	0.28	0.40	-45%
1999	0.19	0.13	33%
2000	0.25	0.00; No C-2 Discharge	No C-2 Discharge
2001	0.05	0.14	-168%
2002	0.002	0.001	66%
2003	0.12	0.09	24%
2004	3.03	0.00; No C-2 Discharge	No C-2 Discharge
2005	0.12	0.15	-30%
Total	4.10	0.96	77%

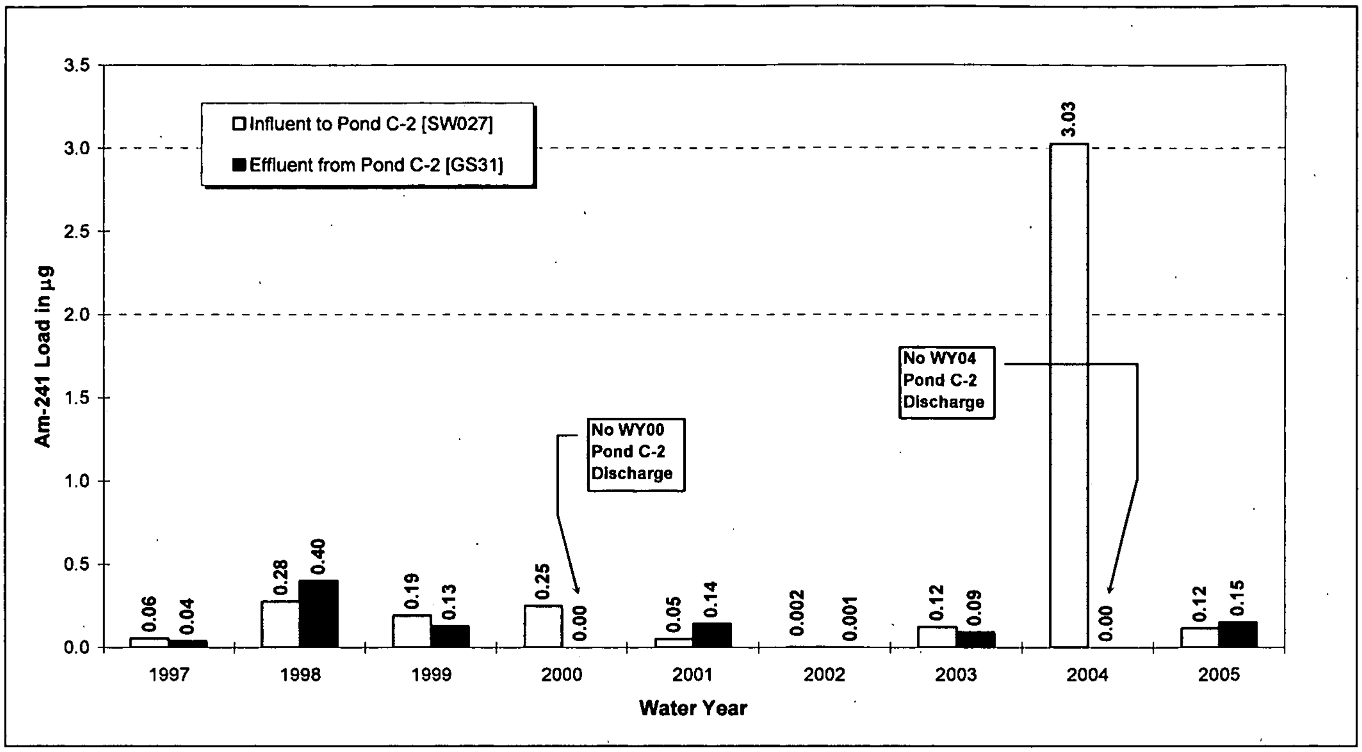


Figure 5-50. Annual Am Loads for Pond C-2: WY97–05.

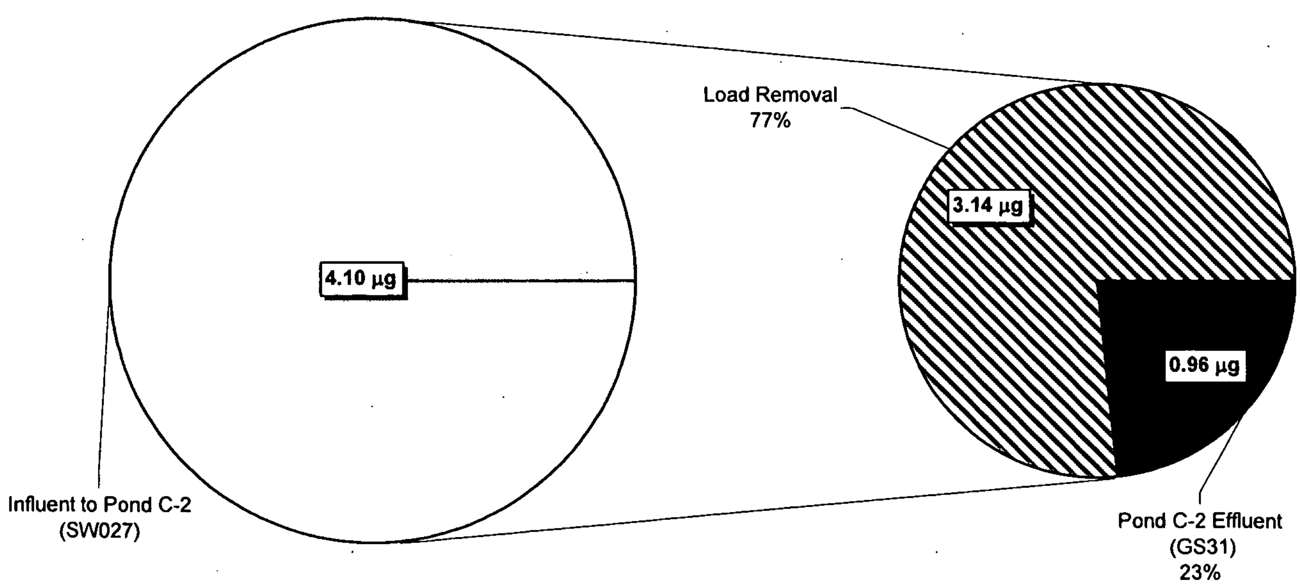


Figure 5-51. Relative Am Load Totals for Pond C-2: WY97–05.

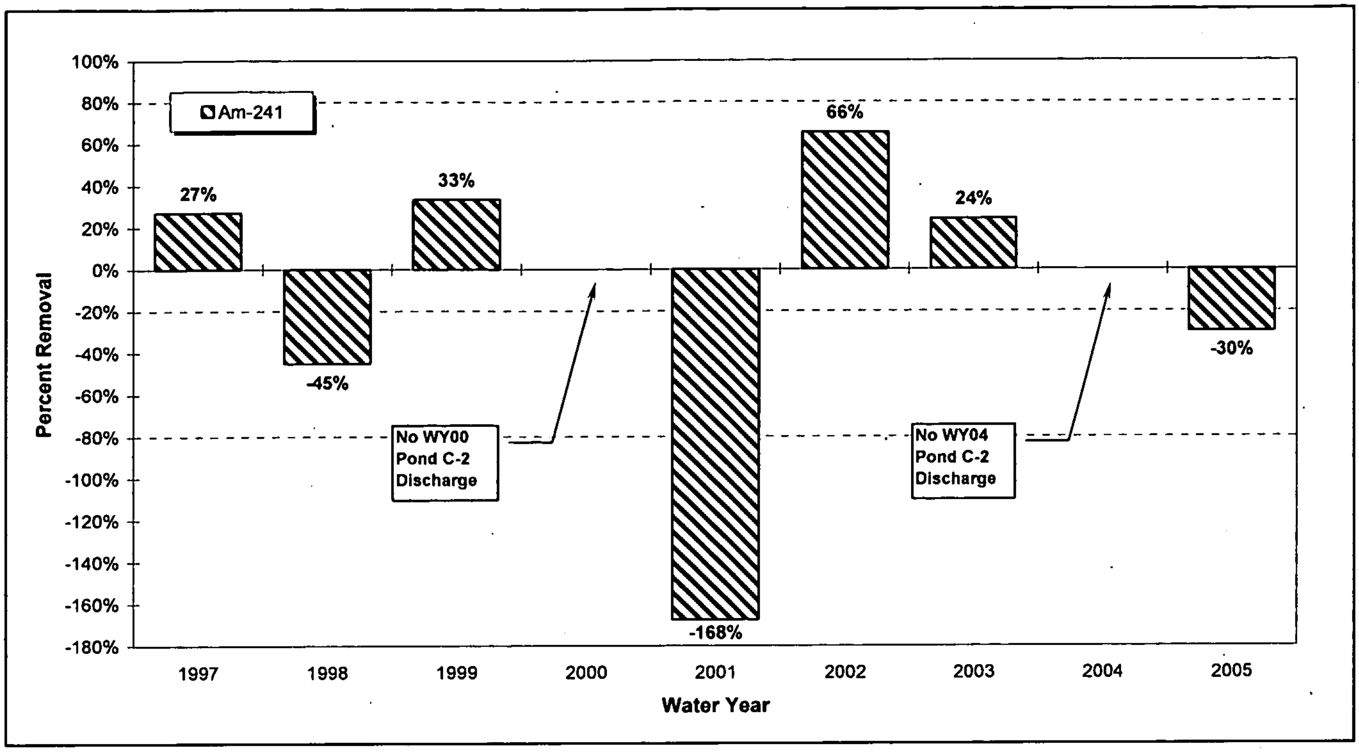
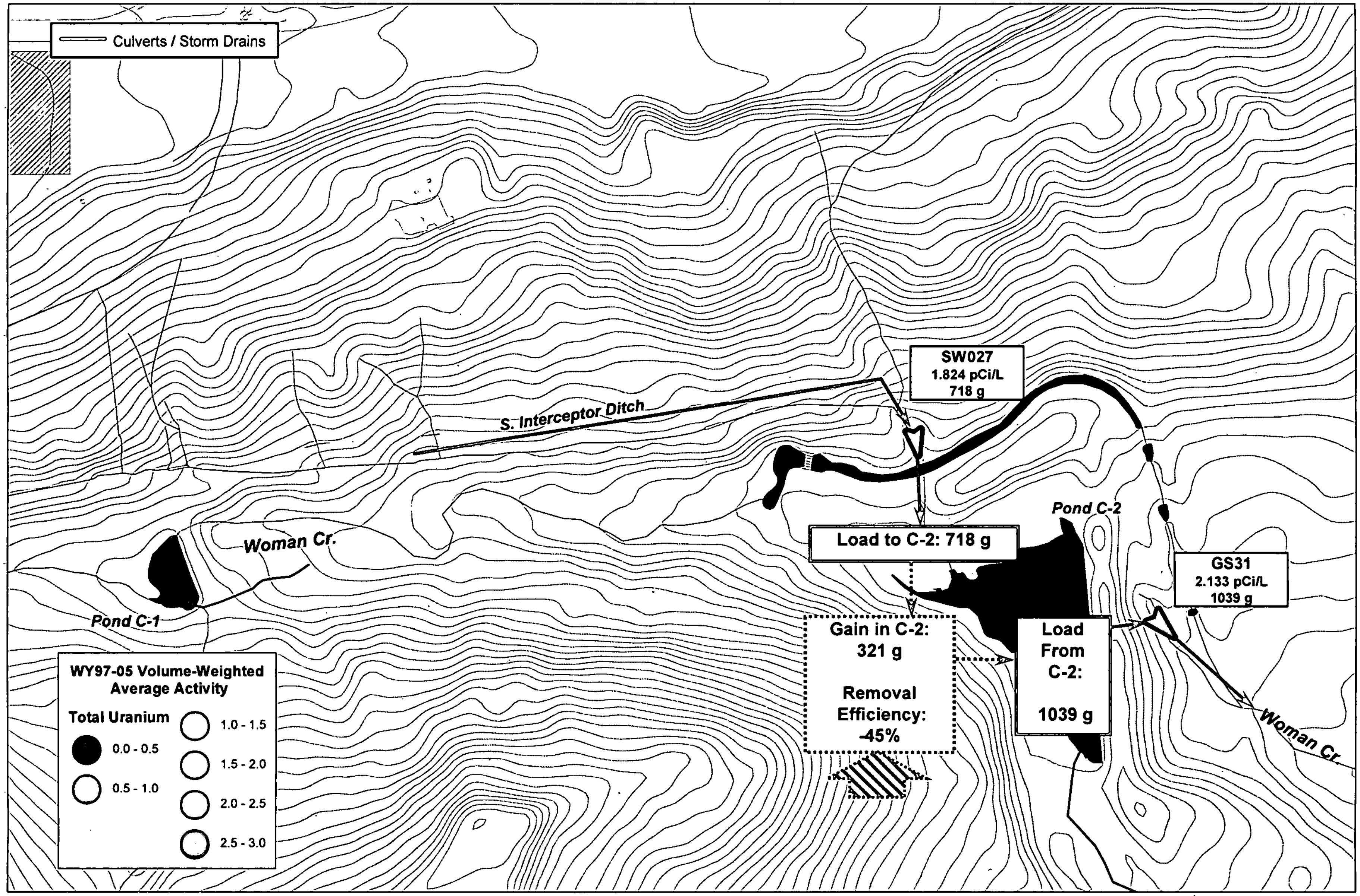


Figure 5-52. Annual Am Load Removal for Pond C-2: WY97–05.



Note: Location symbols are displayed proportional to calculated load and shaded according to activity ranges in legend.

Figure 5-53. Relative Total Uranium Loading Schematic for Pond C-2: WY97-05.

Table 5-17. Total Uranium Load Summary for Terminal Pond C-2: WY97–05.

	Total Uranium (g)		
Water Year	**Influent (SW027)**	**Effluent (GS31)**	**Percent Removal**
1997	66	103	-57%
1998	256	343	-34%
1999	113	189	-67%
2000	26	0.00; No C-2 Discharge	No C-2 Discharge
2001	66	67	-1%
2002	6	1	89%[b]
2003	112	129	-15%
2004	36	0.00; No C-2 Discharge	No C-2 Discharge
2005	37	207	-465%
Total	718	1039	-45%

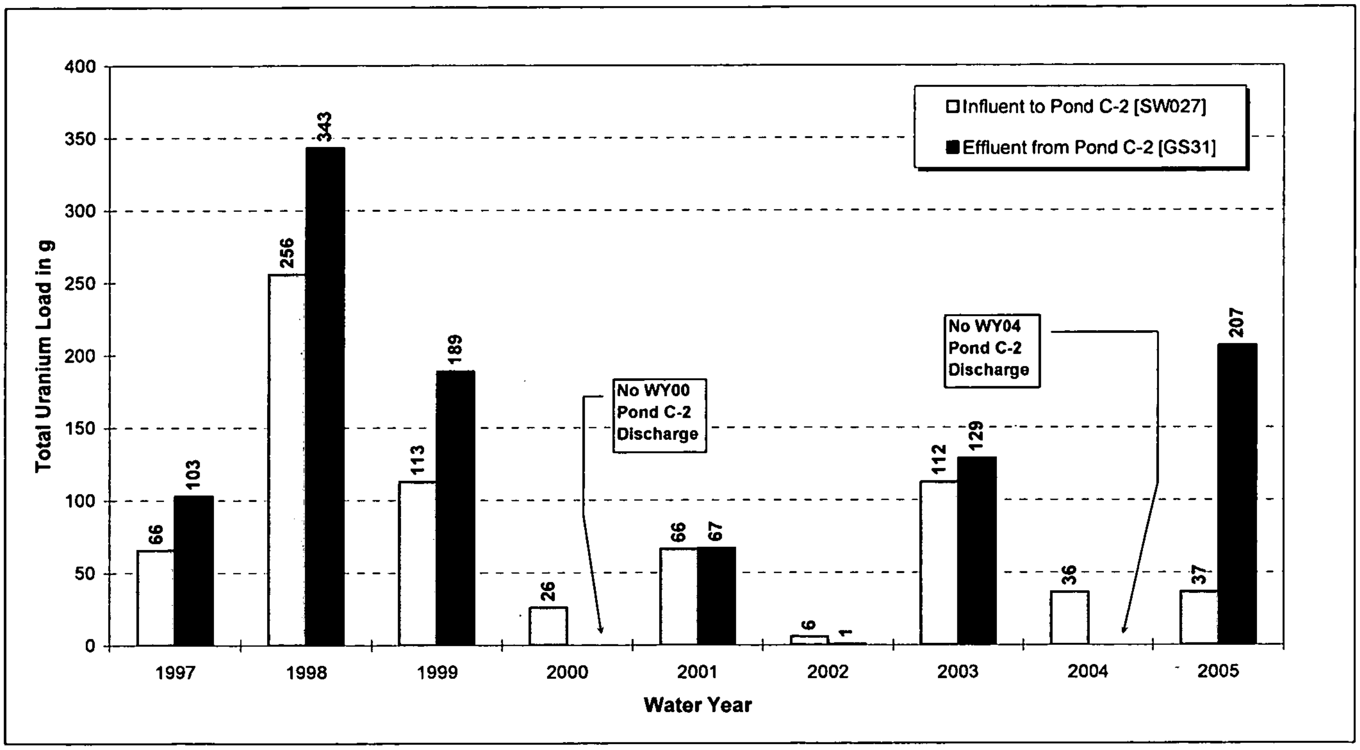


Figure 5-54. Annual Total Uranium Loads for Pond C-2: WY97–05.

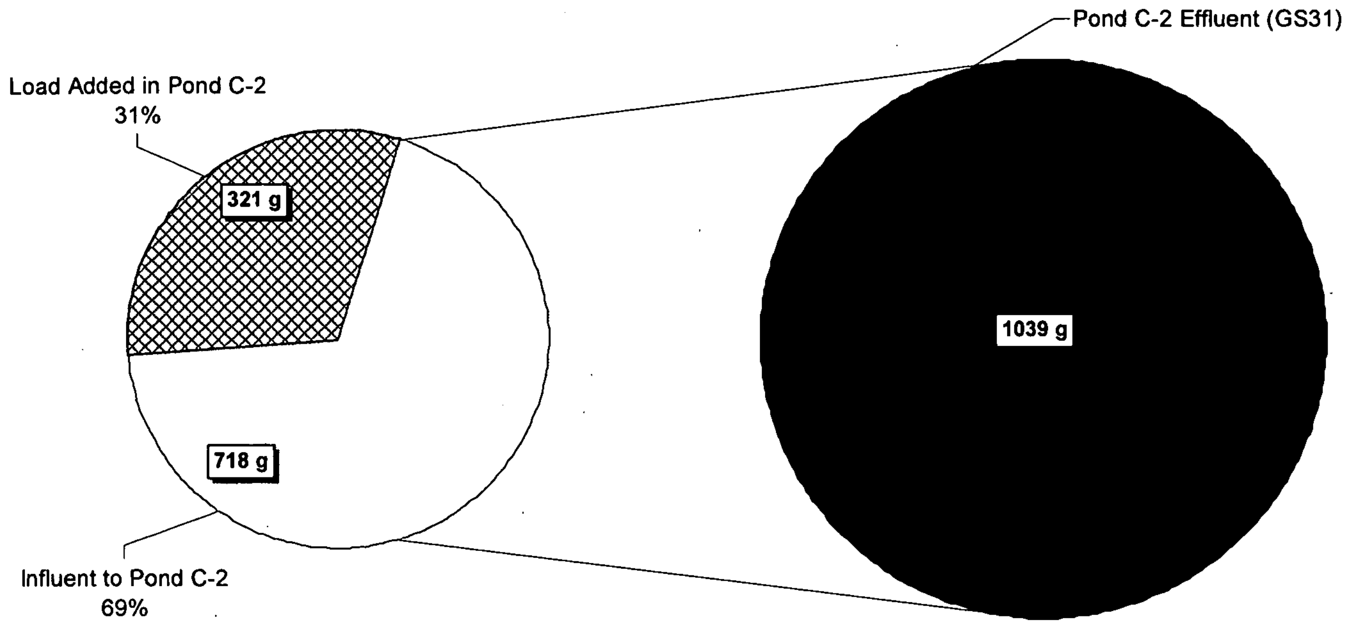


Figure 5-55. Relative Total Uranium Load Totals for Pond C-2: WY97–05.

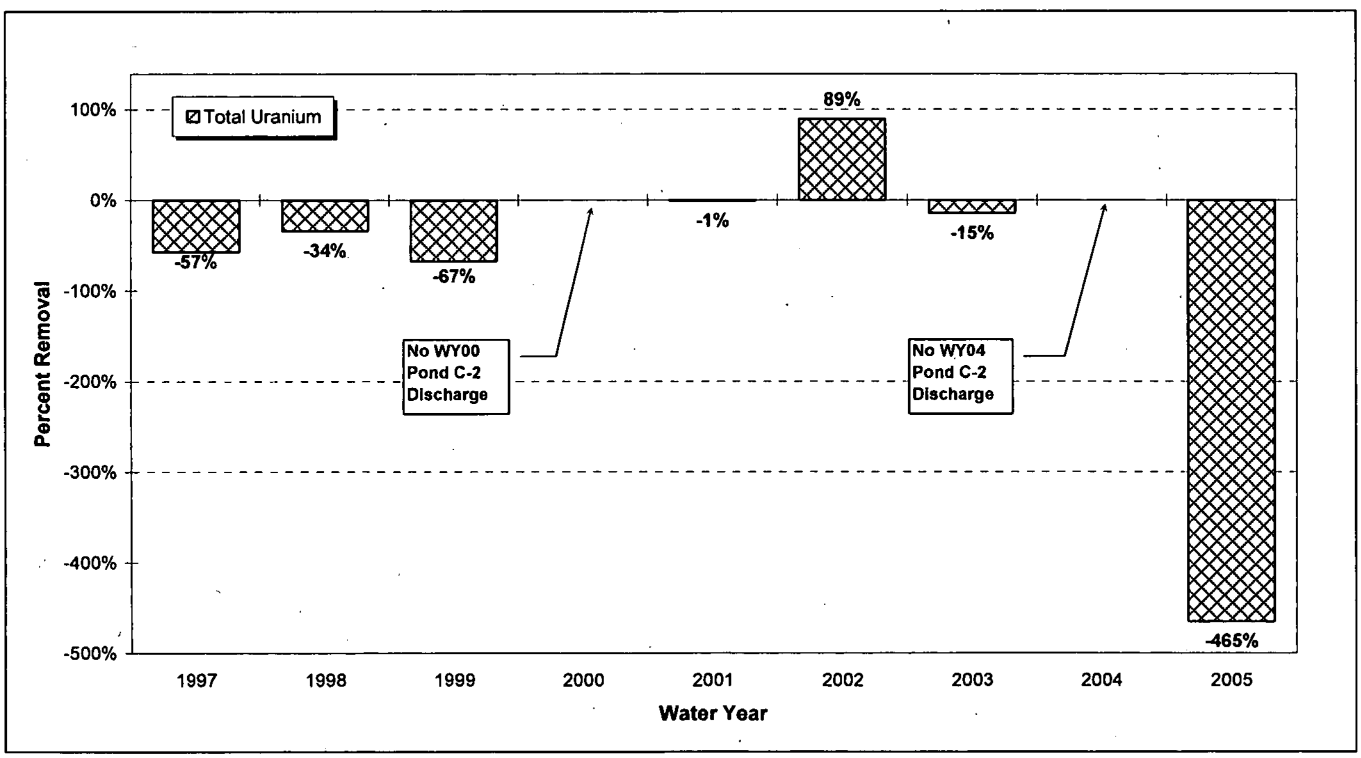


Figure 5-56. Annual Total Uranium Load Removal for Pond C-2: WY97–05.

5.6 RFCA POINTS OF EVALUATION

5.6.1 Major IA Drainages

This section summarizes the calculated Pu, Am, and total uranium loads for the three major IA drainages: North Walnut Creek (SW093)[30], South Walnut Creek (GS10 and the WWTP), and the SID (SW027)[31]. The following points are noted:

- Total Pu load from the IA varies year-to-year and shows a significant increase in WY04 (Figure 5-57). With the enhanced implementation of erosion controls, revegetation, and soil stabilization, a significant reduction is noted for WY05.
- Total Am load from the IA also varies year-to-year and shows a measurable increase in WY04 (Figure 5-59). Since the B771 pathway was not eliminated until December 2004, WY05 Am loads were still higher than normal. Data from SW093 later in WY05 clearly show that the B771 pathway elimination was successful.
- South Walnut Cr. accounts for a majority (46%) of the Pu load from the IA (Figure 5-58). Of the South Walnut Cr. Pu load, GS10 accounts for 97% while the WWTP accounts for the remaining 3%.
- South Walnut Cr. accounts for a majority (60%) of the Am load from the IA (Figure 5-60). Of the South Walnut Cr. Am load, GS10 accounts for 96% while the WWTP accounts for the remaining 4%.
- Annual total uranium loads are fairly consistent year-to-year (Figure 5-65). The data may suggest a slight decreasing trend.
- Total uranium loads are evenly divided (50%-50%) between North and South Walnut Creeks (Figure 5-66).

Table 5-18. Industrial Area Pu and Am Loads: WY97–05.

	Pu-239,240 (μg)				Am-241 (μg)			
Water Year	**N. Walnut [SW093]**	**S. Walnut [GS10]**	**S. Walnut [WWTP]**	**SID [SW027]**	**N. Walnut [SW093]**	**S. Walnut [GS10]**	**S. Walnut [WWTP]**	**SID [SW027]**
1997	178.7	564.0	13.4	14.2	2.27	11.98	0.44	0.06
1998	70.9	345.3	8.7	90.8	1.38	4.95	0.58	0.28
1999	126.9	306.8	23.2	34.1	1.69	12.55	0.11	0.19
2000	88.5	329.6	18.4	67.5	1.03	14.65	0.33	0.25
2001	44.6	140.9	9.1	10.7	0.65	2.71	0.26	0.05
2002	10.0	50.6	7.2	0.2	0.50	1.64	0.23	0.002
2003	138.7	212.4	6.2	45.2	2.06	4.43	0.22	0.12
2004	1301.9	520.9	2.9	815.7	14.36	4.42	0.59	3.03
2005	59.9	255.6	0.0	23.8	14.94	4.47	0.00	0.12
Total	2020.0	2726.2	89.1	1102.1	38.88	61.80	2.75	4.10

[30] Although SW091 is also a load source to North Walnut (Figure 3-2), the flow volumes at SW091 are approximately 0.4% of the volumes at SW093. Additionally, SW091 does not collect continuous flow-paced sample to allow for more accurate load calculations. Therefore, SW091 load is not included due to it's relative insignificance.

[31] As of the publication of this report, the composite sample at SW027 started on 5/18/05 was still in progress. SW027 has not flowed since 6/14/05 and the composite currently contains 2.2 liters, a non-sufficient quantity for analysis. Therefore, the activity for the period 5/18-10/1/05 was estimated as the volume-weighted activity for WY05 using the available data.

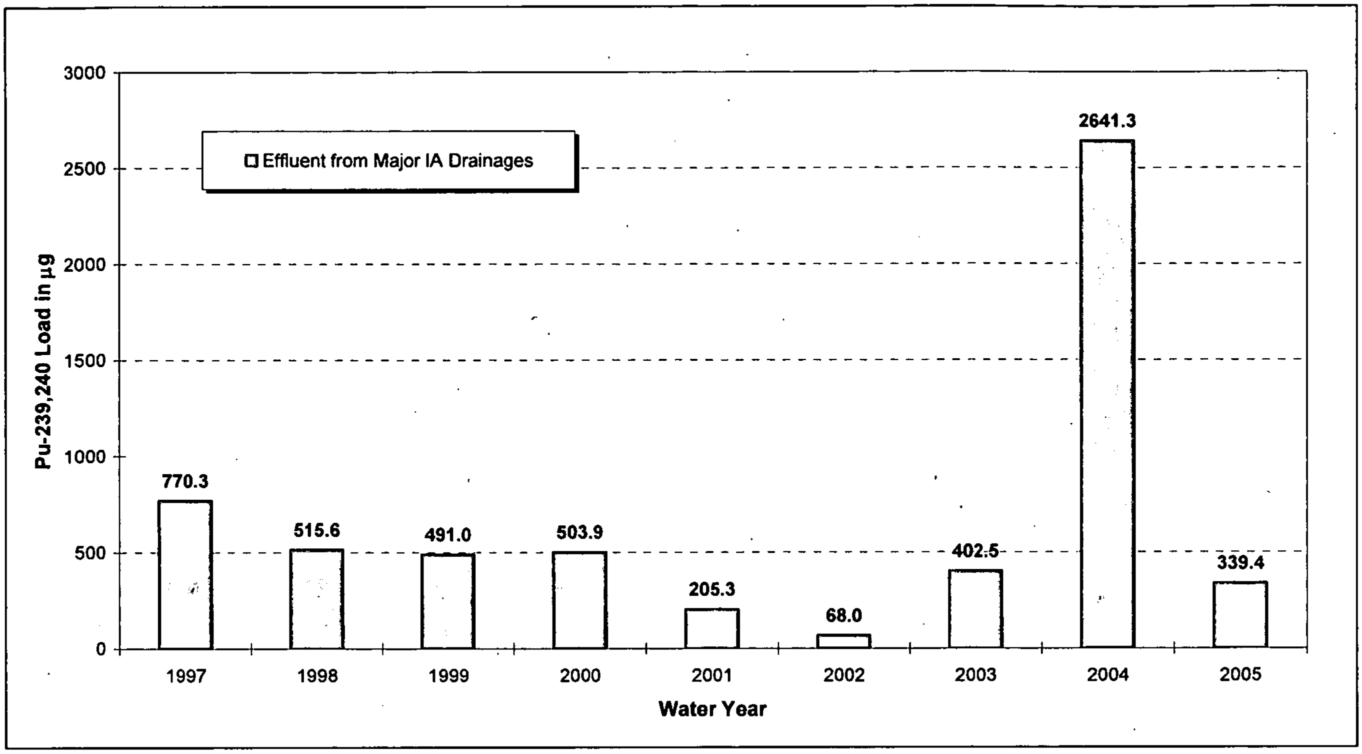


Figure 5-57. Combined Annual Pu Loads from Major IA Drainages and WWTP: WY97–05.

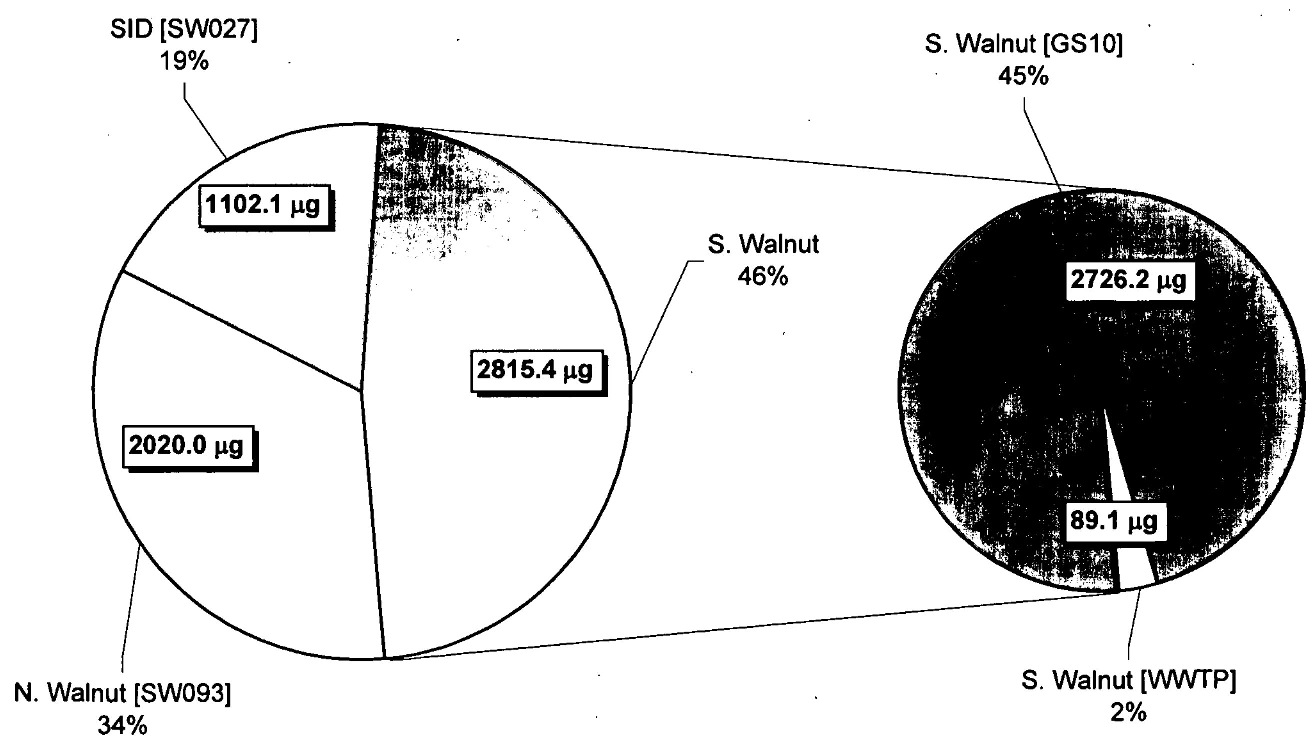


Figure 5-58. Relative Pu Load Totals from Major IA Drainages and WWTP: WY97–05.

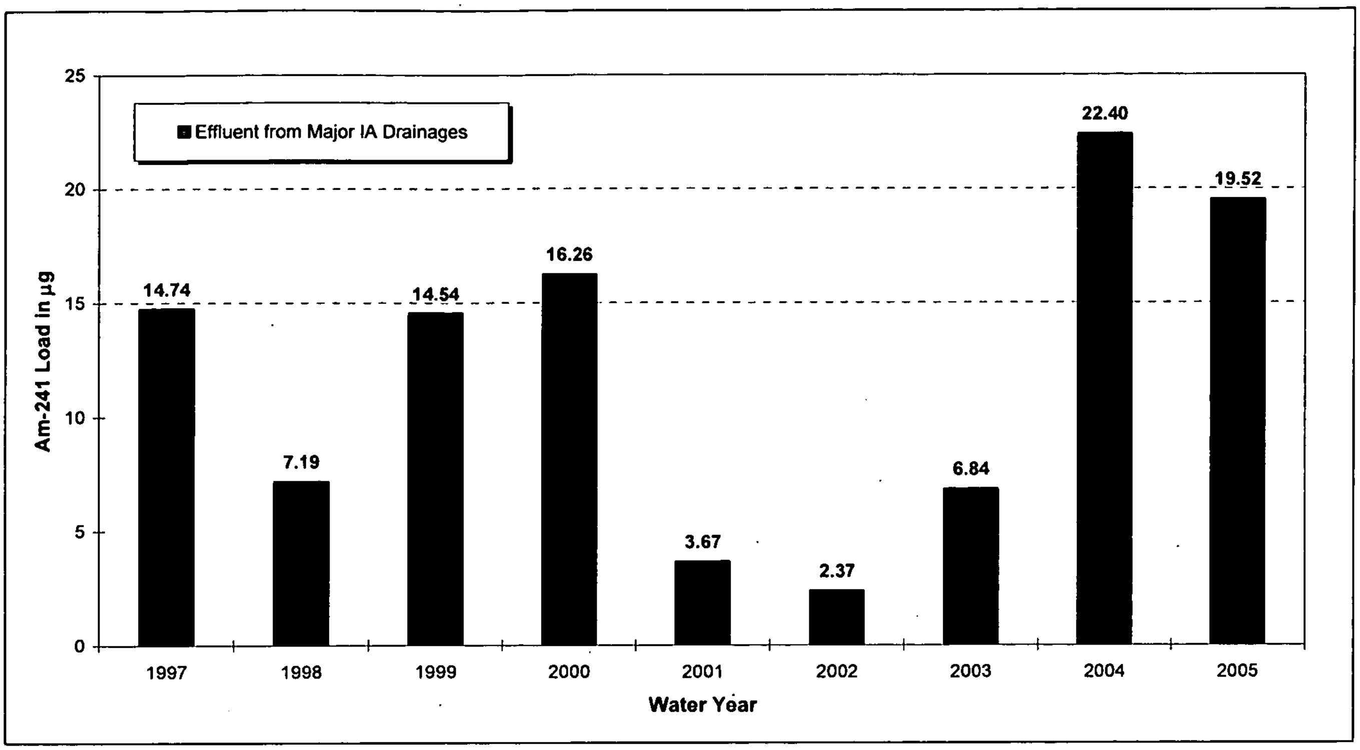


Figure 5-59. Annual Am Loads from Major IA Drainages and WWTP: WY97–05.

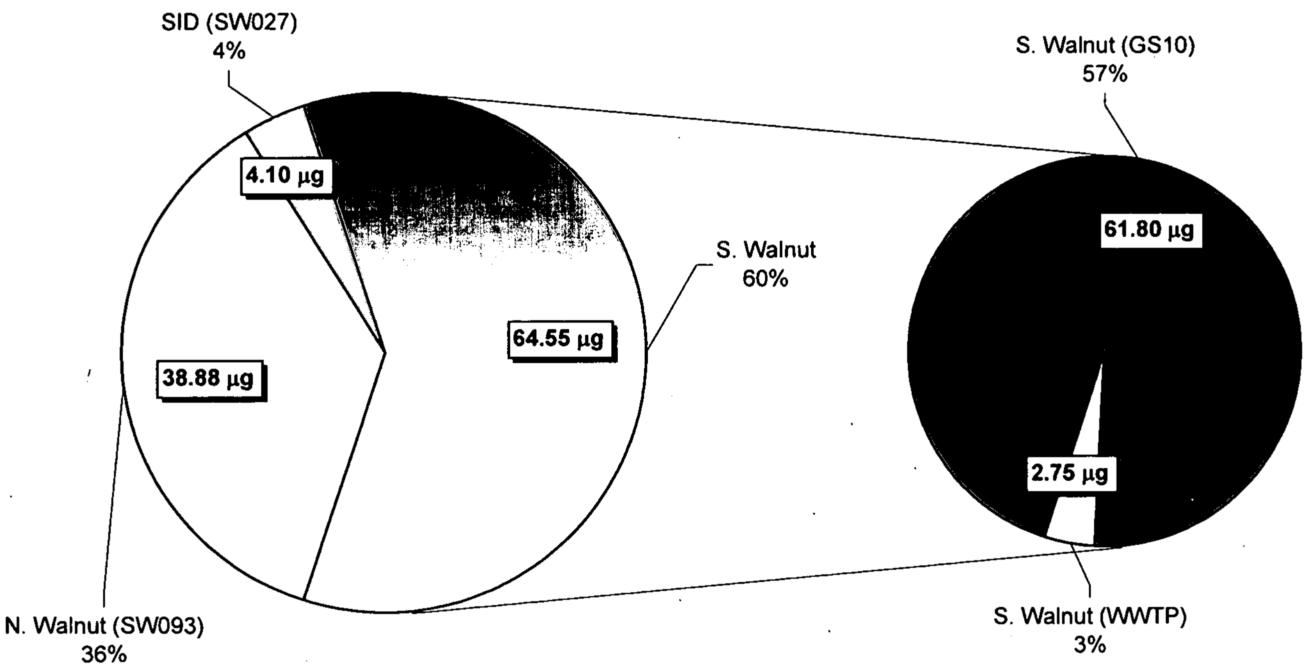


Figure 5-60. Relative Am Load Totals from Major IA Drainages and WWTP: WY97–05.

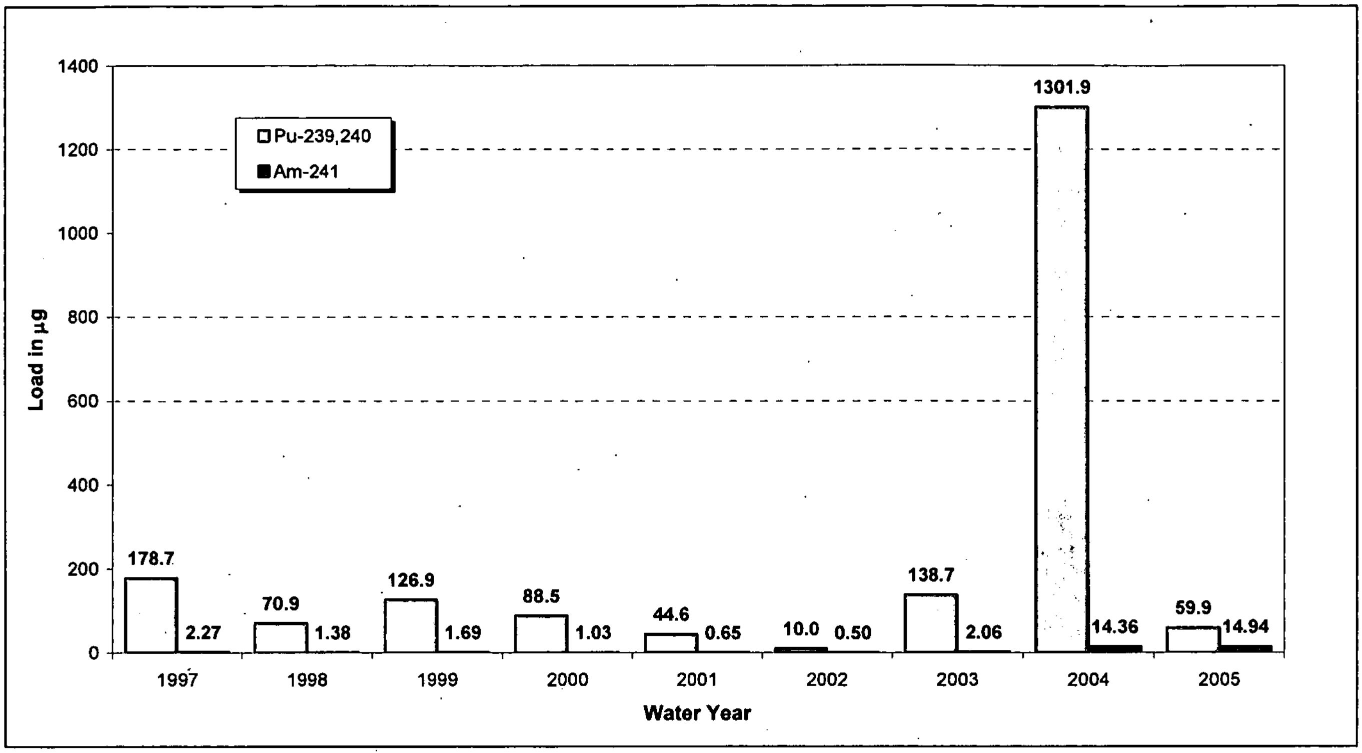


Figure 5-61. Annual Pu and Am Loads at SW093: WY97–05.

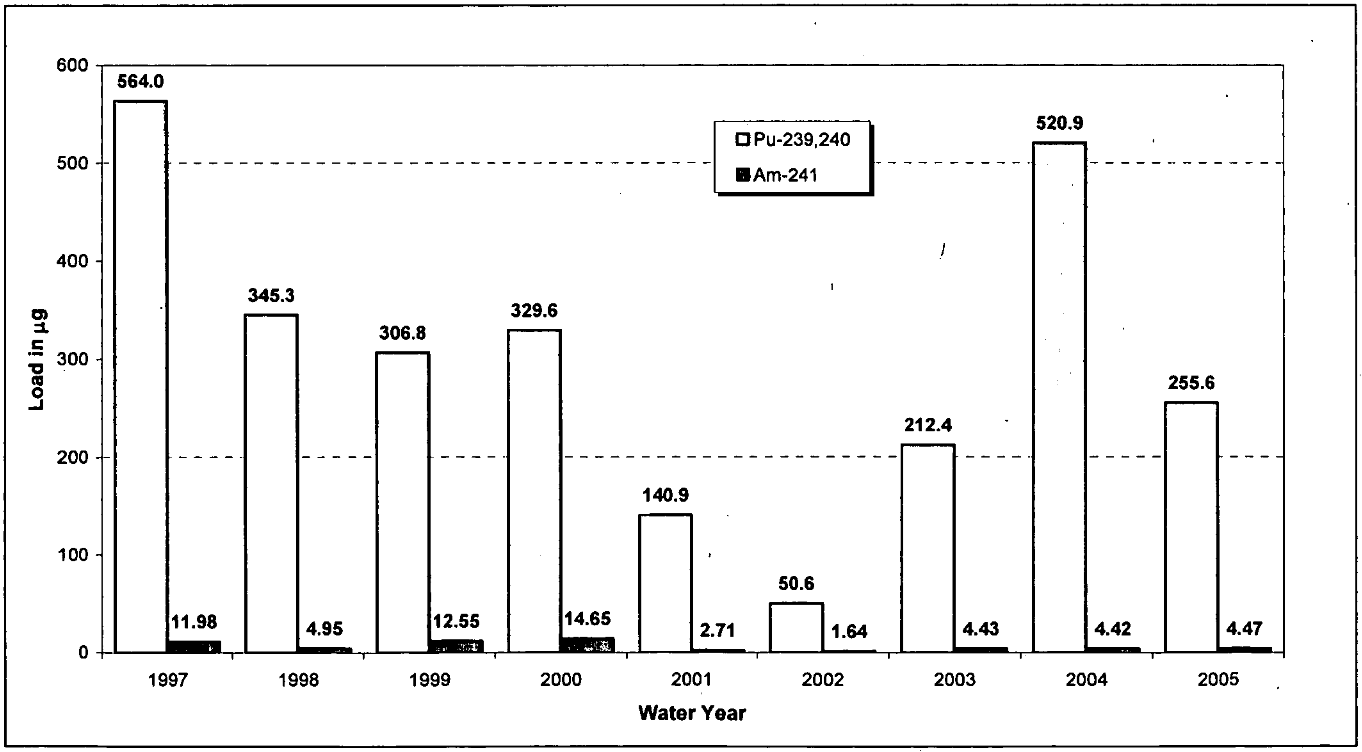


Figure 5-62. Annual Pu and Am Loads at GS10: WY97–05.

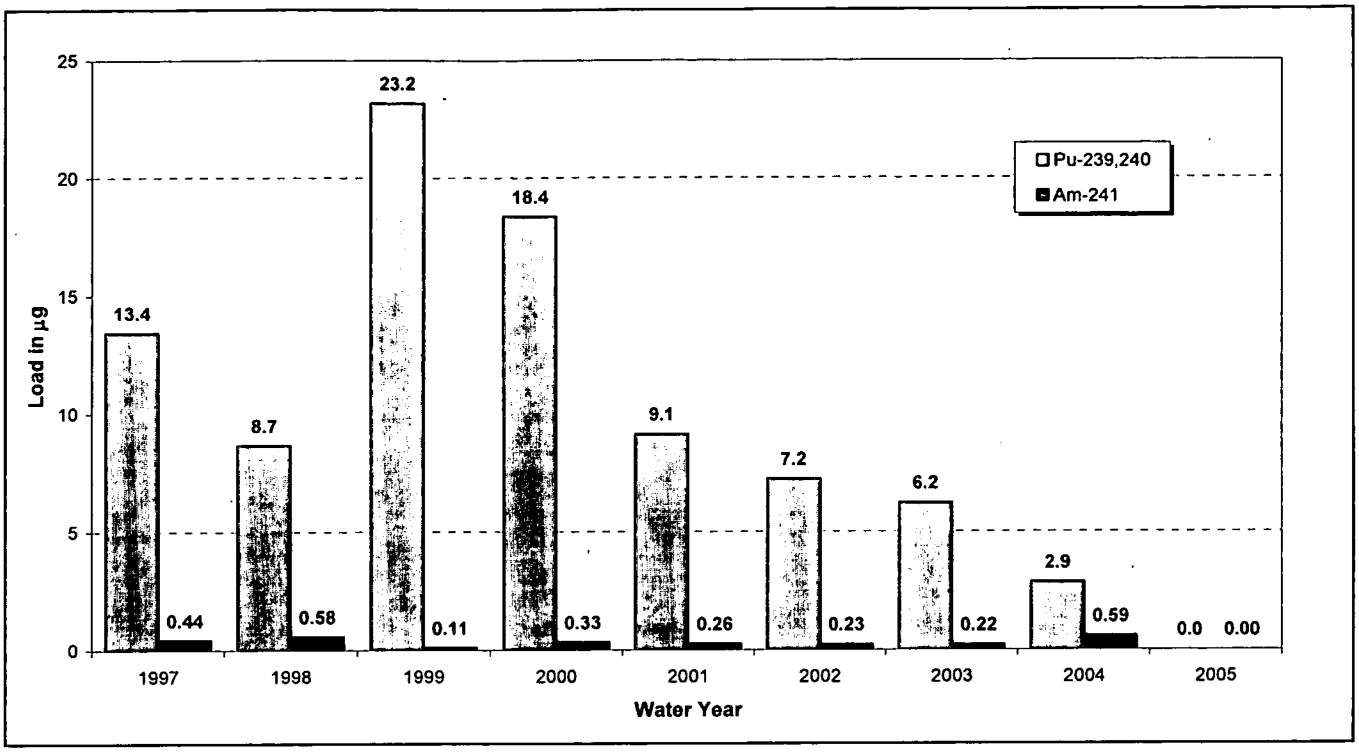


Figure 5-63. Annual Pu and Am Loads at the WWTP: WY97–05.

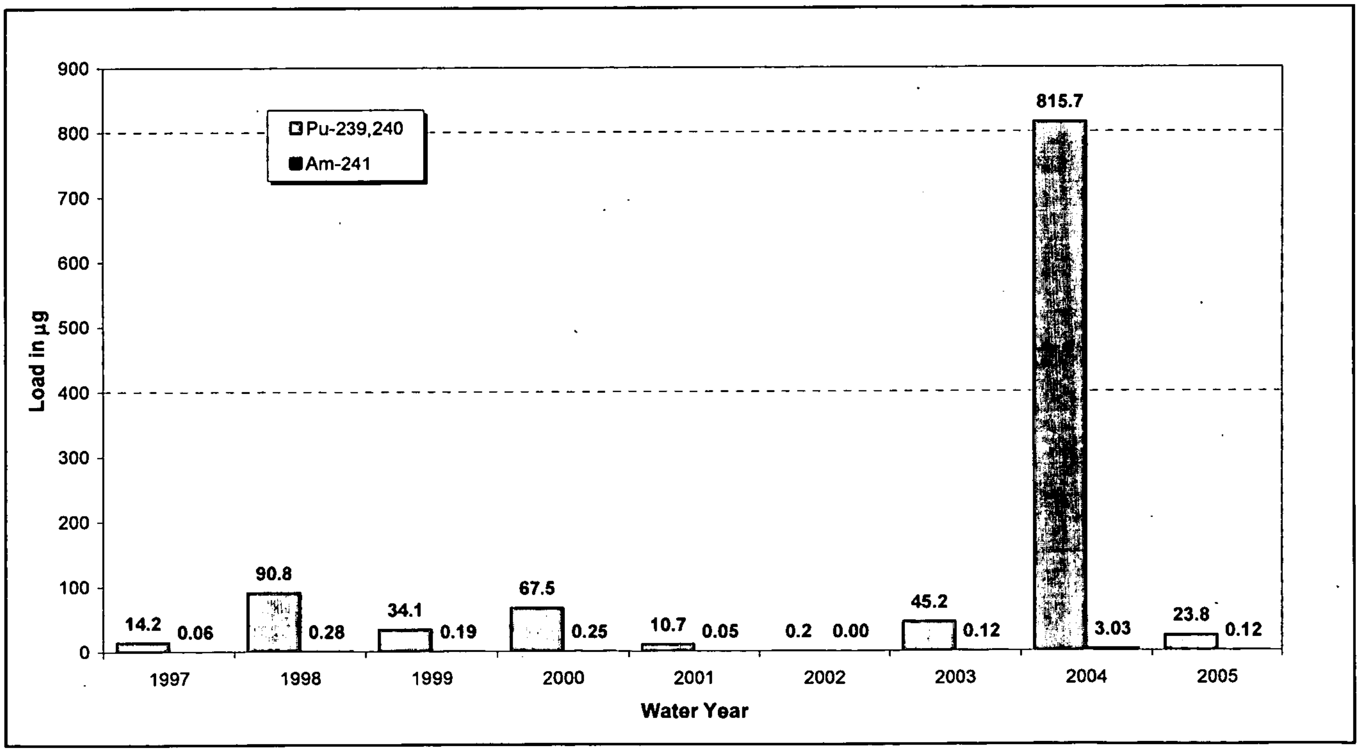


Figure 5-64. Annual Pu and Am Loads at SW027: WY97–05.

Table 5-19. Industrial Area Total Uranium Loads: WY97–05.

	Total Uranium (g)			
Water Year	**N. Walnut [SW093]**	**S. Walnut [GS10]**	**S. Walnut [WWTP]**	**SID [SW027]**
1997	783	560	218	66
1998	881	683	516	256
1999	680	577	108	113
2000	534	399	110	26
2001	641	518	254	66
2002	439	288	75	6
2003	663	516	161	112
2004	441	360	146	36
2005	569	865	7	37
Total	5632	4767	1594	718

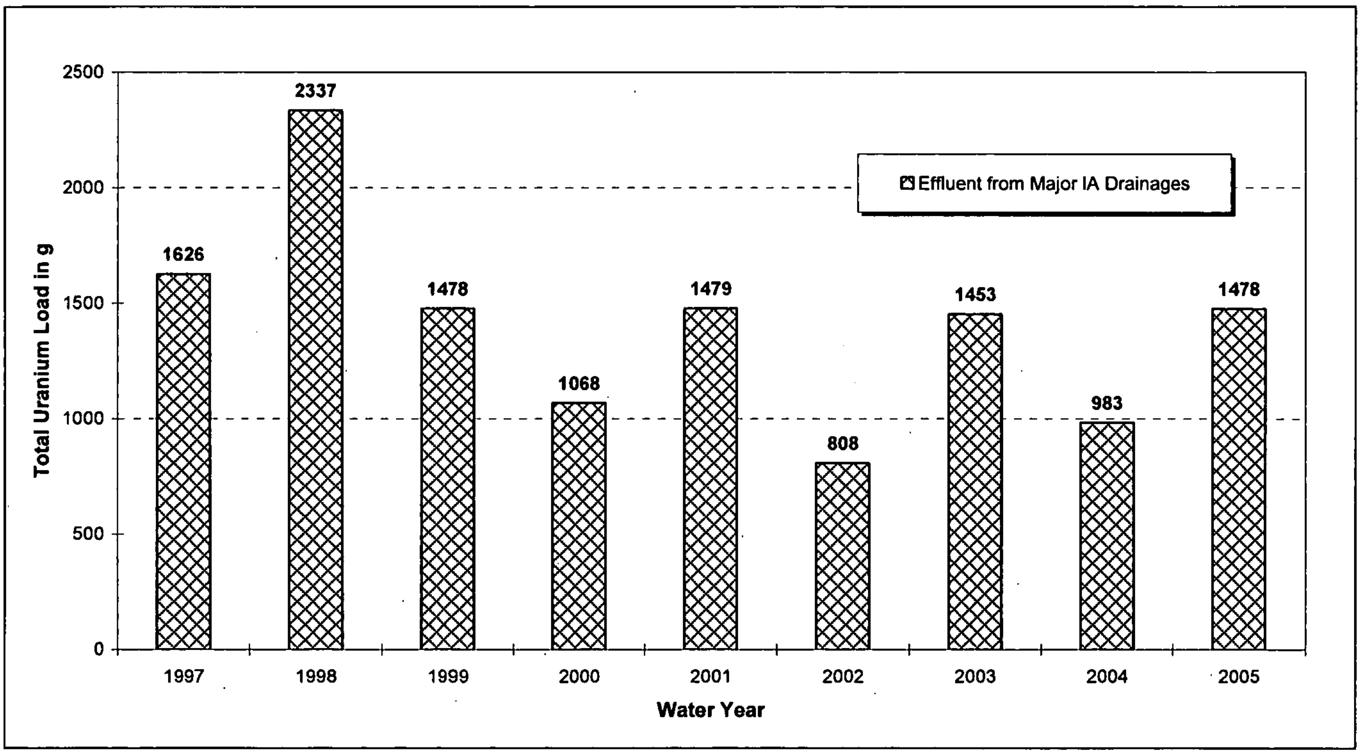


Figure 5-65. Annual Total Uranium Loads from Major IA Drainages and WWTP: WY97–05.

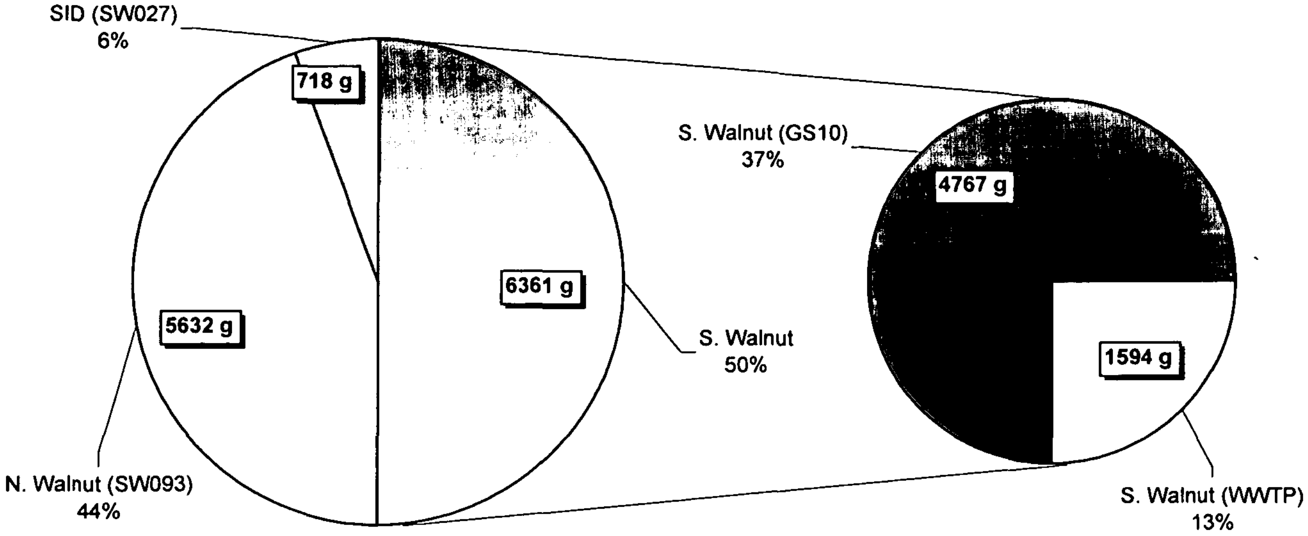


Figure 5-66. Relative Total Uranium Load Totals from Major IA Drainages and WWTP: WY97–05.

5.7 LOADING ANALYSIS SUMMARY

5.7.1 Walnut Creek

The following summarizes the loading analysis for the WY97-05 period in Walnut Creek:

- GS10 accounts for 45% of the Pu load and 57% of the Am load transported from the IA. GS10 accounts for 56% of the Pu load and 60% of the Am load transported from the IA to the A- and B-Series Ponds.
- SW093 accounts for 44% of the total uranium transported from the IA. SW093 accounts for 47% of the total uranium load transported from the IA to the A- and B-Series Ponds.
- Site retention ponds are generally effective at removing Pu and Am from the water column through physical settling. The A- and B-Series Ponds remove 82% of the Pu load and 89% of the Am load transported from the IA. A portion of the Am load removal is due to treatment of Pond A-4 during WY05.
- Site retention ponds have very little effect on uranium activities. Since uranium is far more likely to be transported as a dissolved constituent, lack of removal by physical settling is expected. The A- and B-Series retention ponds show a slight loss (5%) in total uranium loads.
- Pond B-5 accounts for 77% of the Pu load and 67% of the Am load discharged from the Site terminal ponds. Pond B-5 accounts for 83% of the Pu load and 73% of the Am load discharged from the A- and B-Series Ponds to lower Walnut Creek.
- Pond A-4 accounts for 47% of the total uranium load discharged from the Site terminal ponds. Pond A-4 accounts for 51% of the total uranium load discharged from the A- and B-Series Ponds to lower Walnut Creek.
- For lower Walnut Creek, there is a small Pu load loss (6%) between the A- and B-Series ponds and GS03. For Am, there is a small load gain (10%).

- For lower Walnut Creek, there is a total uranium load gain (7%) between the A- and B-Series ponds and GS03.[32]
- Walnut Creek (GS03) accounts for 78% of both the Pu and Am loads leaving the Site (Woman and Walnut Creeks). Annual Pu and Am loads vary by up to two orders of magnitude year-to-year and appear to be decreasing at GS03. The slight increase in Am loads at GS03 during WY05 is due to increased Am contributions in N. Walnut Creek associated with B771 (see Section 6.3.3). Treatment of Pond A-4 water was successful in reducing Am levels to well below the applicable standard (0.15 pCi/l), but the Am activity of the discharged water was somewhat higher than normal. Pond B-5 also showed some increased Am due to temporarily increased Am load associated with solids transport resulting from the construction of Functional Channel #4. These slightly higher activities were subsequently measured at GS03.
- Walnut Creek (GS03) accounts for 62% of the total uranium load from the Site (Woman and Walnut Creeks).[32]

5.7.2 Woman Creek

The following summarizes the loading analysis for the WY97-05 period in Woman Creek:

- SW027 accounts for 19% of the Pu load and 4% of the Am load transported from the IA.
- SW027 accounts for 6% of the total uranium transported from the IA.
- Site retention ponds are generally effective at removing Pu and Am from the water column through physical settling. Pond C-2 removes 93% of the Pu load and 77% of the Am load transported from the IA.
- Site retention ponds have very little effect on uranium activities. Since uranium is far more likely to be transported as a dissolved constituent, lack of removal by physical settling is expected. There is a measurable total uranium load gain in Pond C-2 (45%). This may be caused by groundwater with naturally occurring uranium entering Pond C-2 downstream of SW027. WY2002 shows abnormally high removal, possibly due to the drought conditions resulting in less groundwater flowing to the pond downstream of SW027.
- Pond C-2 accounts for 8% of both the Pu and Am loads discharged from the Site terminal ponds.
- Pond C-2 accounts for 8% of the total uranium load discharged from the Site terminal ponds.
- For lower Woman Creek, there is a significant Pu load gain (2159%) and Am load gain (273%) between Pond C-2 and GS01. This is due to much larger flow volumes, but low activities at GS01.
- For lower Woman Creek, there is a significant total uranium load gain (636%) between Pond C-2 and GS01.[32] This is due to much larger flow volumes with naturally occurring uranium, but low activities at GS01.
- Woman Creek (GS01) accounts for 22% of both the Pu and Am loads leaving the Site (Woman and Walnut Creeks). Annual Pu and Am loads vary by up to two orders of magnitude year-to-year and appear to be decreasing at GS01.
- Woman Creek (GS01) accounts for 38% of the total uranium load from the Site (Woman and Walnut Creeks).[32]

[32] Uranium analysis at both GS01 and GS03 began in WY03.

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6. SOURCE LOCATION MONITORING

As used in this section, a "source" is a contaminant source. The term "new source", as used in this section, means any source that has not previously been located, halted, mitigated, quantified, or corrected.

When new contaminant sources are detected by surface-water monitoring at an NSD location, POE, POC, or in a downstream reservoir, additional monitoring may be required to identify[33] the source and evaluate for corrective actions pursuant to the RFCA Action Level Framework (ALF). The Source Location monitoring objective is intended to locate the source of contamination when a new source of contamination is detected.[34]

The monitoring details in Section 6.1 are based on Source Location monitoring performed in WY05.

6.1 DATA TYPES, FREQUENCY, AND COLLECTION PROTOCOLS

Source Location monitoring may be implemented anywhere within a Site surface-water drainage area (including within the IA) where a new contaminant source is detected. The selection of monitoring points is determined by the details of the specific source evaluation to quickly determine source location and to efficiently utilize resources. For example, if monitoring (just outside the IA) through NSD monitoring suggests a new source within the IA, then portable sampling equipment may be installed within the IA, to locate the source. Similarly, if monitoring for compliance in Segment 4 (POC) suggests a new source, then monitoring to identify the source may begin in Segment 5.

Source Location monitoring should begin as soon as practicable after initial source detection and continue until the source is identified and/or evaluated or is no longer detected. The number of samples will be based on the status of the source evaluation, taking into account, but not limited to, weather conditions, water availability, and process knowledge.

Analyte suites under this monitoring objective are determined based on the detected contaminant of current concern, or related indicators. The information types are entirely dependent on the results of other monitoring objectives under which the source was detected. The analyte suites are limited to parameters that will aid in the identification and evaluation of a contaminant source.

Flow data is collected, where possible, to provide flow volumes required for contaminant loading analysis. Samples collected are continuous flow-paced composites (if possible) to facilitate comparison to POCs and POEs and allow for continuous contaminant loading analysis. Collection of real-time water-quality data may be initiated if such data facilitate the specific source evaluation.

The specific scope for each source location investigation is detailed in either a sampling and analysis plan (SAP) or included as part of a Letter of Notification from the Site to the regulators.

6.2 WY05 MONITORING SCOPE

Table 6-1 lists the Source Location monitoring locations that were operational during WY05. Figure 2-1 shows the location of these monitoring stations.

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[33] Note that the term "identify" is used here to mean "locate." Characterization may be warranted but it is not specified in the document.

[34] The various monitoring objectives might "detect" a new source through an increase in baseline or exceedance of an action level, standard, permit limitation, etc., depending on the monitoring objective under which the potential new source was detected.

Table 6-1. Source Location Monitoring Locations.

Location Code	Location	Flow Measurement Device	Telemetry	Notes
GS21	Culvert SE of B664	1.0' H-Flume	Yes	Supports ongoing source evaluation for SW027 and B664 D&D
GS22	Outfall to SID draining 400 Area	1.5' H-Flume	Yes	Supports ongoing source evaluation for SW027 and 400 Area D&D
GS28	Small ditch NW of B865	3" Parshall flume	Yes	Supports ongoing source evaluation for GS10 and 800 Area D&D
GS32	Corrugated metal pipe (cmp; 1.5') north of Solar Ponds in PA draining B779 area	NA[a]	Yes	Supports source evaluation for SW093 and B779 and B776/777 D&D
GS38	Central Ave. Ditch NW of Building 889	9.5" Parshall Flume	Yes	Supports ongoing source evaluation for GS10
GS39	Ditch NW of 904 Pad	1' H Flume	Yes	Supports ongoing source evaluation for GS10 and 903 Pad accelerated actions
GS40	Drainage Ditch in former PA east of Tenth St. (750 Pad) south of Building 997	1' Parshall Flume	Yes	Supports ongoing source evaluation for GS10 and 700 Area D&D
GS42	Gulch tributary to SID 150' above POE SW027	3" Parshall Flume	Yes	Supports ongoing source evaluation for SW027 and 903 Pad accelerated actions
GS49	Ditch NW of B566	6" Parshall flume	Yes	Supports source evaluation for SW093 and B776/777 D&D
GS50	Drainage ditch north of B990	6" Parshall flume	Yes	Supports ongoing source evaluation for GS10 and Solar Ponds accelerated actions
GS51	Ditch along abandoned road south of 903 Pad just upstream of SID	0.75' H-Flume	Yes	Supports ongoing source evaluation for SW027 and 903 Pad accelerated actions
GS52	Gully SSE of 903 Pad just upstream of SID	0.6' HS-Flume	No	Supports ongoing source evaluation for SW027 and 903 Pad accelerated actions
GS53	Gully SE of 903 Pad just upstream of SID	0.6' HS-Flume	No	Supports ongoing source evaluation for SW027 and 903 Pad accelerated actions
GS54	Gully ESE of 903 Pad just upstream of SID	0.6' HS-Flume	No	Supports ongoing source evaluation for SW027 and 903 Pad accelerated actions

Location Code	Location	Flow Measurement Device	Telemetry	Notes
GS55	Outfall to SID draining B881 area	120° V-Notch Weir	Yes	Supports ongoing source evaluation for SW027 and B881 D&D
GS57	Ditch NE of B444 Area	9.5" Parshall flume	Yes	Supports ongoing source evaluation for GS10 and 400 Area D&D
GS60	Ditch NE of B371 along former PA perimeter road	6" Parshall Flume	Yes	Supports source evaluation for SW093 and B371/374 D&D
GS61	Confluence of ditches west of 231 Tanks	9" Montana Flume	Yes	Supports source evaluation for SW093 and B371/374 D&D
SW018	On N. Walnut Cr. tributary south of 771 trailers	1' Parshall Flume	Yes	Supports source evaluation for SW093 and B371/374 D&D
SW021	Culvert east of former PA draining B991 Area	1.5' H-flume	Yes	Supports ongoing source evaluation for GS10 and B991 D&D
SW022	Central Avenue Ditch at inner east fence	9.5" Parshall flume	Yes	Supports ongoing source evaluation for GS10
SW036	SID downstream of Original Landfill	6" Parshall flume	Yes	Supports ongoing source evaluation for SW027 and Original Landfill accelerated actions
SW119	Ditch north of Solar Ponds inside former PA	9" Parshall flume	Yes	Supports source evaluation for SW093 and Solar Ponds accelerated actions
SW120	Drainage ditch north of Solar Ponds along former PA perimeter road	4" Cutthroat Flume	Yes	Supports source evaluation for SW093 and B771/774 D&D and Solar Ponds accelerated actions

Notes: All locations collect 5- and 15-minute flow data.
[a] Due to the current configuration of in-place stormwater culverts, flow measurement at this location is not possible without significant construction modifications.

Table 6-2. Source Location Sample Collection Protocols.

Location Code	Frequency: WY05 Actual (Target)	Type[b]
GS21	6 (11 per year[a]); discontinued 6/30/05	Continuous flow-paced composites
GS22	5 (4 per year[a]); discontinued 3/24/05	Continuous flow-paced composites
GS28	4 (8 per year[c]); discontinued 5/3/05	Continuous flow-paced composites
GS32	3 (1 per month[c]); discontinued 3/1/05	Storm-event rising-limb time-paced composites[c]
GS38	9 (9 per year[a]); discontinued 6/6/05	Continuous flow-paced composites
GS39	8 (7 per year[a]); discontinued 5/17/05	Continuous flow-paced composites
GS40	17 (17 per year[a]); discontinued 8/3/05	Continuous flow-paced composites
GS42	3 (2 per year[c]); discontinued 9/7/05	Continuous flow-paced composites
GS49	12 (17 per year[a]); discontinued 8/30/05	Continuous flow-paced composites
GS50	2 (0 per year[c]); discontinued 3/22/05	Continuous flow-paced composites

Location Code	Frequency: WY05 Actual (Target)	Type[b]
GS51	9 (10 per year[c])	Continuous flow-paced composites
GS52	8 (11 per year[c]); discontinued 9/7/05	Continuous flow-paced composites
GS53	1 (9 per year[c]); discontinued 9/7/05	Continuous flow-paced composites
GS54	5 (1 per year[c]); discontinued 9/7/05	Continuous flow-paced composites
GS55	6 (11 per year[a]); discontinued 9/12/05	Continuous flow-paced composites
GS57	15 (17 per year[a]); discontinued 7/18/05	Continuous flow-paced composites
GS60	11 (13 per year[a]); discontinued 7/21/05	Continuous flow-paced composites
GS61	10 (9 per year[a]); discontinued 8/22/05	Continuous flow-paced composites
SW018	21 (20 per year[a])	Continuous flow-paced composites
SW021	2 (2 per year[a]); discontinued 12/6/04	Continuous flow-paced composites
SW022	5 (2 per year[a]); discontinued 4/17/05	Continuous flow-paced composites[d]
SW036	3 (0 per year[c]); discontinued 3/17/05	Continuous flow-paced composites
SW119	2 (0 per year[a]); discontinued 3/1/05	Continuous flow-paced composites
SW120	2 (0 per year[a]); discontinued 3/15/05	Continuous flow-paced composites

Notes: [a] Annual total samples is 12 per year. Frequency of collection is based on expected flow volumes such that each sample collects water representing similar stream discharge volumes; for example, more samples are collected in wet spring months than dry winter months.
[b] Sample types are defined in Appendix B.
[c] Storm-event sampling at locations that are often dry and normally only receive stormwater runoff is opportunistic. Some locations may see flow only during wet months. Every attempt is made to achieve the target sample frequency; however, this is not always possible.
[d] Prior to WY00, SW022 collected storm-event samples.

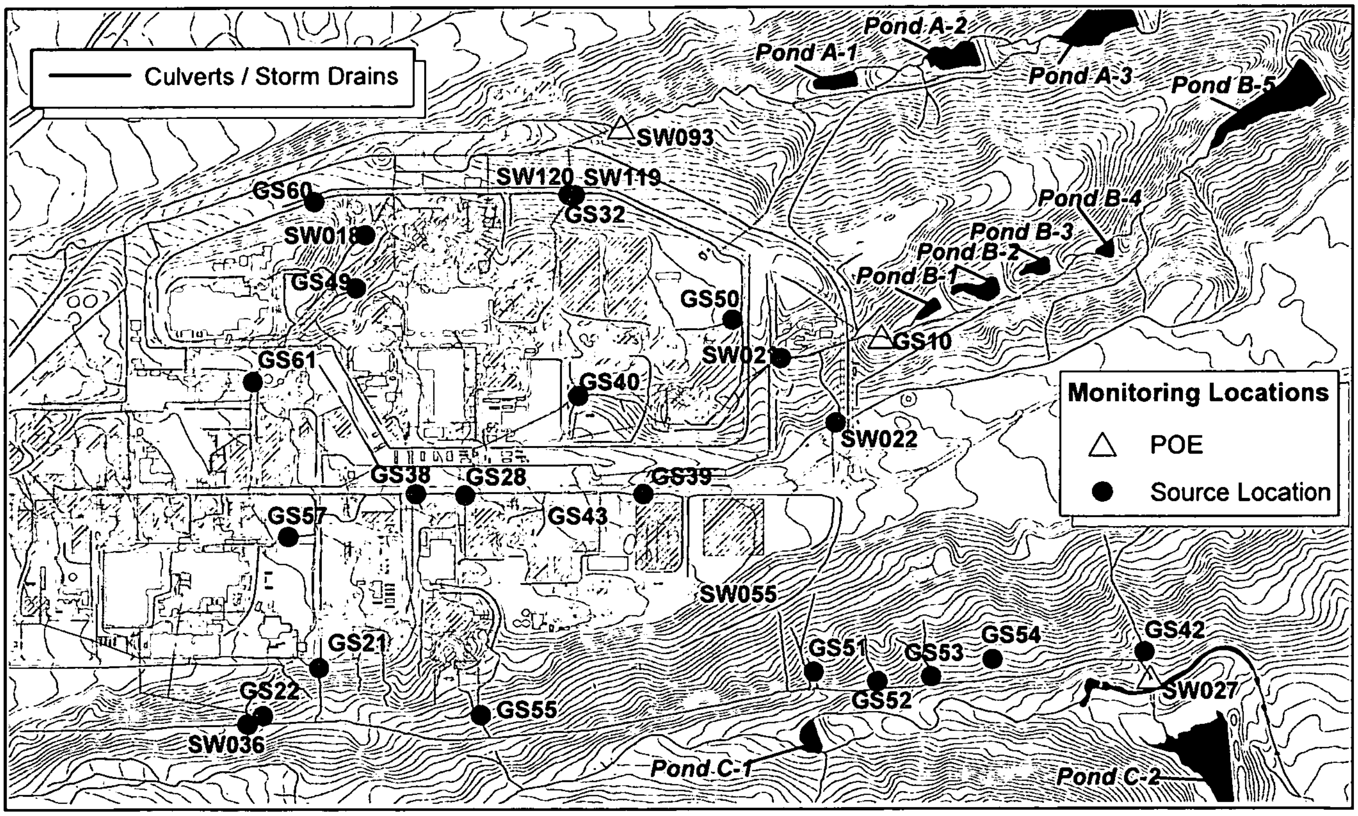

Figure 6-1. WY05 Source Location Monitoring Locations.

Table 6-3. Source Location Analytical Targets (Analyses per Year).

Location Code	TSS[a]: WY05 Actual (Target)	Pu, Am: WY05 Actual (Target)
GS21	0 (11)	6 (11)
GS22	0 (4)	5 (4)
GS28	0 (8)	4 (8)
GS32	3 (1)	3 (1)
GS38	1 (9)	9 (9)
GS39	3 (7)	8 (7)
GS40	1 (17)	17 (17)
GS42	2 (2)	3 (2)
GS49	4 (17)	12 (17)
GS50	0 (0)	2 (0)
GS51	4 (10)	9 (10)
GS52	5 (11)	8 (11)
GS53	0 (9)	1 (9)
GS54	5 (1)	5 (1)
GS55	1 (11)	6 (11)
GS57	6 (17)	15 (17)
GS60	2 (13)	11 (13)
GS61	2 (9)	10 (9)
SW018	4 (20)	21 (20)
SW021	0 (2)	2 (2)
SW022	1 (2)	5 (2)
SW036	0 (0)	3 (0)
SW119	2 (0)	2 (0)
SW120	1 (0)	1 (0)

Notes: [a] Ideally, TSS would be analyzed for all samples collected at the above locations. However, continuous flow-paced sampling protocols often result in composite samples which are collected over periods exceeding the 7-day hold time for TSS analyses. Therefore, TSS can not be analyzed for all continuous flow-paced composite samples, but will be analyzed when possible.

6.3 DATA EVALUATION

Data collected at Source Location monitoring locations are analyzed based on their ability to aid in a specific source evaluation. These analyses include, but are not limited to, loading, fate and transport, correlations and trending, and other statistical evaluation. The WY05 source evaluation locations were operated in support of the WY05 source evaluations for POEs GS10, SW027, and SW093. The recurring nature of reportable Pu and Am values at the POEs necessitated the continued operation of these locations. Past source evaluation reports contain more detailed analysis of the data collected for the above locations. The content of these reports is summarized below. Updated source evaluation summaries are also provided in this report.

Summaries for Pu and Am at each location are given below. The following summaries include all results that were not rejected through the verification and validation process. Data are generally presented to decimal places as reported by the laboratories. Accuracy should not be inferred; minimum detectable concentrations/activities and analytical error are often greater than the precision presented. When a negative radionuclide result (e.g. -0.002 pCi/L) is reported by the laboratory due to blank correction, then a value of 0.0 pCi/L is used for calculation purposes. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the 'real' and the 'duplicate' values. When a sample has multiple 'real' analyses (Site requested 'reruns'), the value used in calculations is the arithmetic average of the multiple 'real' analyses. Other data are evaluated in the associated Source Evaluation Reports. All data are presented in Appendix B.2 Analytical Data.

Flow data are summarized in Section 3 Hydrologic Data. Detailed flow data are included in Appendix A.1 Discharge Data.

6.3.1 Location-Specific Summary Statistics

Table 6-4 shows both the volume-weighted average activity and the maximum sample activity for Pu and Am at the WY05 Source Location monitoring locations. The method for calculating the volume-weighted activities is given in Appendix B.1 Data Evaluation Methods.

When individual results are rejected during the validation process, an activity is estimated[35] for the composite sampling period with the rejected result. Volume-weighted average activities that include estimated results are *italicized* in Table 6-4 and the corresponding maximum activities are for only the measured results.

Table 6-4. Selected Summary Statistics for Pu and Am at WY05 Source Location Monitoring Locations.

		Volume-Weighted Average Activity (pCi/L)		Maximum Sample Activity (pCi/L)	
Location	**Period of Data**	***Am-241***	***Pu-239,240***	***Am-241***	***Pu-239,240***
GS28	10/1/04 – 5/3/05	0.014	0.051	0.035	0.139
GS38	10/1/04 – 6/6/05	0.132	2.12	0.280	10.6
GS39	10/1/04 – 5/17/05	*0.308*	1.178	1.42	7.23
GS40	10/1/04 – 7/28/05	*0.211*	0.615	0.741	2.84
GS50	10/1/04 – 3/22/05	2.30	0.907	12.8	7.36
GS57	10/1/04 – 7/18/05	0.019	0.041	0.075	0.236
SW021	10/1/04 – 11/18/04	0.373	0.095	0.494	0.194
SW022	10/1/04 – 3/31/05	0.051	0.095	0.129	0.174
GS10	10/1/04 – 9/30/05	0.166	0.197	1.53	1.01
GS21	10/1/04 – 6/30/05	0.058	0.259	0.242	1.42
GS22	10/1/04 – 3/24/05	0.032	0.069	0.109	0.242
GS42	10/1/04 – 9/7/05	0.172	0.603	0.251	0.891
GS51	10/1/04 – 9/30/05	0.914	3.47	1.78	8.46
GS52	10/1/04 – 9/7/05	0.403	2.49	0.650	3.95
GS53	10/1/04 – 4/30/05	0.101	0.267	0.199	0.300
GS54	10/1/04 – 6/10/05	*0.133*	*1.02*	0.347	2.50
GS55	10/1/04 – 6/8/05	0.018	0.025	0.044	0.040
SW036	10/1/04 – 3/17/05	0.000	0.001	0.000	0.002
SW027[36]	10/1/04 – 9/30/05	*0.032*	*0.136*	0.083	0.293

[35] The estimated activity is based on average activities for valid samples, TSS-activity correlations, and or Pu/Am ratios.

[36] As of the publication of this report, the composite sample at SW027 started on 5/18/05 was still in progress. SW027 has not flowed since 6/14/05 and the composite currently contains 2.2 liters, a non-sufficient quantity for analysis. Therefore, the activity for the period 5/18-10/1/05 was estimated as the volume-weighted activity for WY05 using the available data.

		Volume-Weighted Average Activity (pCi/L)		Maximum Sample Activity (pCi/L)	
Location	**Period of Data**	***Am-241***	***Pu-239,240***	***Am-241***	***Pu-239,240***
GS32	10/1/04 – 3/1/05	NA	NA	2.05	1.45
GS49	10/1/04 – 8/30/05	0.121	0.321	0.380	0.935
GS60	10/1/04 – 7/21/05	*0.090*	0.256	1.25	3.94
GS61*	10/30/04 – 8/5/05	*0.028*	*0.080*	0.104	0.266
SW018	10/9/04 – 9/30/05	*0.015*	*0.030*	0.091	0.197
SW119	10/1/04 – 3/1/05	0.094	0.040	0.157	0.044
SW120	10/1/04 – 2/24	0.170	0.158	0.231	0.199
SW093	10/1/04 – 9/30/05	*0.445*	0.037	14.1	0.497

Note: NA = Volume-weighted average activities are not calculated for storm-event sampling locations. Locations GS27, GS28, GS38, GS39, GS43, and GS57 are tributary to SW022 before GS10. Location GS57 is tributary to GS38 before SW022. Location GS50 is tributary to SW021 before GS10. Locations GS49 and GS61 are tributary to SW018 before SW093.
Italics: volume-weighted activity includes estimated sample activities
- Missing flow and sample data from GS61 due to temporary location shutdown for process waste line excavations; values are estimates.

6.3.2 Summary of Completed Source Evaluations for POE GS10

WY97 Source Evaluation for Walnut Creek

The WY97 Walnut Creek Source Evaluation Reports (Reports #1, #2, #3, and Final; RMRS 1997a, 1997b, 1997c, and 1998a) included source evaluations for POC GS03 and POEs GS10 and SW093. These reports were completed in response to reportable water-quality values at these locations during WY97. The scope of the investigation for each report is summarized below.

The following text is taken directly from Progress Report #1 to the Source Evaluation and Preliminary Mitigation Plan for Walnut Creek, Rev. 0 (RMRS 1997a) describing the contents of that report related to GS10:

- An evaluation of sampling and analysis QA/QC protocol to verify elevated water-quality results;
- Results and analysis of ongoing RFCA monitoring;
- A summary of current AME findings with cross-links to source evaluations;
- Details on the new monitoring locations upgradient of GS10;
- An initial qualitative evaluation for GS10;
- A discussion of the recent change from rising-limb to continuous flow-paced sampling at RFCA POE and POC locations; and
- A summary of the status for sampling and operational modifications.

The following text is taken directly from Progress Report #2 to the Source Evaluation and Preliminary Mitigation Plan for Walnut Creek, Rev. 0 (RMRS 1997b) describing the contents of that report for GS10:

- Hypotheses for source location(s) with supporting and non-supporting information, including preliminary results on source location;
- Results and analysis of ongoing RFCA monitoring;
- A summary of walk-down activities and observations for GS10;
- An assessment of existing monitoring data for GS10;
- A detailed description of new sediment/soil sampling locations for GS10;

- A detailed description of proposed new Source Location monitoring stations for GS10;
- A summary of current AME findings with cross-links to source evaluations; and
- A summary of the status for sampling and operational modifications.

The following text is taken directly from Progress Report #3 to the Source Evaluation and Preliminary Mitigation Plan for Walnut Creek, Rev. 0 (RMRS 1997c) describing the contents of that report for GS10:

- Results and analysis of ongoing RFCA monitoring;
- Updates to the ongoing GS10 evaluation;
- Updates for the new Source Location monitoring stations for GS10;
- An evaluation of the effects that watershed improvements may have had on Site water quality;
- A summary of current AME findings with cross-links to source evaluations; and
- A summary of the status for sampling and operational modifications.

The following text is taken directly from the Final Report to the Source Evaluation and Preliminary Mitigation Plan for Walnut Creek, Rev. 0 (RMRS 1998a) describing the contents of that report for GS10:

- Updates to the ongoing GS10 evaluation;
- Results and analysis of ongoing RFCA monitoring;
- An assessment and incorporation of available new data for GS10;
- Updates for the new Source Location monitoring stations for GS10;
- Hypotheses for source location(s) with supporting and non-supporting information;
- An identification of data gaps and uncertainties in the source evaluation process with suggested modifications (if any) to the AME Work Scope and the IMP;
- A summary of current AME findings with cross-links to source evaluations;
- A summary of the status for sampling and operational modifications;
- Results of the source location evaluation;
- A detailed description of identified source areas; and
- A general description of mitigating actions applicable to sources which may be identified in the future.

Taken directly from Final Report, the following findings regarding the possible source(s) of the reportable values at GS10 were noted:

> To date, a singular source for GS10 can not be identified. Information collected to date does not point to any singular conclusion. In fact, it is likely that multiple sources and transport mechanisms are responsible for the elevated activities at GS10. *To date, no localized areas of radiological contamination have been identified — either historical or resulting from current operations. The Site concludes that the likely source of the exceedance of the 30-day average for Pu and Am at POE GS10, resulted from diffuse radionuclide contamination from past Site operations released to the environment through events and conditions over past years.*

The Final Report further lists the possible GS10 source(s):

- Diffuse soil and sediment contamination in the GS10 drainage;
- Localized contamination near the GS10 sampling location; and
- A tributary surface-water source transporting contamination.

WY98–99 Source Evaluation for POE GS10

The WY98–99 Source Evaluation Report for Point of Evaluation GS10 (RMRS 1999a) was completed in response to reportable water-quality values at GS10 during WY98 and WY99. The following text is taken directly from that report describing the contents:

- Results and analysis of ongoing automated surface-water monitoring;
- A brief review of existing soil and sediment data;
- An assessment of D&D, Environmental Remediation (ER), and Site Closure projects; and
- A summary of current AME findings.

This following text taken directly from that report summarizes the findings, and presents preliminary conclusions for GS10 based on information presented and analyzed in that report:

- Surface-water, soil, and sediment sampling results suggest that one or more low-level distributed actinide source areas exist within the GS10 drainage. Further, surface-water activities have been of similar magnitudes for the last decade, suggesting that source areas originated as legacy contamination.
- Surface-water sampling results from GS10 show Pu/Am activity ratios that are distinguishable from Pu/Am ratios at other surface-water monitoring locations at the Site. This suggests a source relatively 'enriched' in Am may exist in the GS10 drainage.
- Recent surface-water sampling results from Source Location monitoring stations has further refined the estimation of relative Pu load contributions to GS10 from upstream subdrainage areas. These load estimations suggest that Pu source terms may exist in the following subdrainage areas:
    - The Central Avenue Ditch reach between surface-water monitoring locations GS38 and SW022
    - Portions of the 800 Area
    - A portion of the 500 Area outside the PA, and
    - The South Walnut Creek reach between surface-water monitoring locations GS40 and GS10
- Recent surface-water sampling results from Source Location monitoring stations have further refined the estimation of relative Am load contributions to GS10 from upstream subdrainage areas. These load estimations suggest that Am source terms may exist in the following subdrainage areas:
    - A portion of the 500 Area outside the PA, and
    - The South Walnut Creek reach between surface-water monitoring locations GS40 and GS10

- Evaluation of readings from *in-situ* water-quality monitoring probes indicates no unusual or unexpected conditions for WY99 to date. WY99 trends for all parameters are similar to those observed in WY98 and WY97.
- A review of current Site activities indicate that no D&D, ER Projects, excavation, nor routine Site operations caused a release of Pu or Am that resulted in the elevated activities measured at GS10.
- The reportable values observed at GS10 and other monitoring locations in the GS10 drainage are not observed at the Ponds or downstream POCs.

WY00–01 Source Evaluation for POE GS10

The WY00–01 Source Evaluation Report for Point of Evaluation GS10 (RMRS 2001d) was completed in response to reportable water-quality values at GS10 during WY00 and WY01. The following text is taken directly from that report describing the contents:

- Summary of current applicable AME findings;
- Evaluation of ongoing automated surface-water monitoring including automated synoptic sampling within the GS10 drainage;
- Estimation of actinide loads within the GS10 drainage area;
- Evaluation of Pu/Am ratios within the GS10 drainage area;
- Evaluation of water-quality correlations;
- Evaluation of existing soil and sediment data as well as recent sediment sampling within the GS10 drainage; and
- Assessment of D&D, ER, and Site Closure projects.

The following text taken directly from that report summarizes the findings and presents preliminary conclusions for GS10 based on information presented and analyzed in that report:

> The Site concludes that the likely sources of the reportable 30-day moving average values at GS10 are:
>
> 1. Diffuse actinide contamination associated with soils and sediments from past Site releases to the environment through events and conditions over the past years. This actinide contamination is transported with suspended solids in surface-water runoff during precipitation events.
> 2. Actinide contamination 'enriched' in Am that has been incorporated into the stream sediments in South Walnut Creek from past Site operations through events and conditions over past years. This actinide contamination is transported through sediment resuspension by surface-water runoff during precipitation events.
>
> Based on this evaluation, Site personnel conclude that no specific remedial action(s) is indicated at this time, other than scheduled remedial actions and closure activities for the Site. This source investigation has identified no highly localized source(s) of contamination that warrant targeted remediation based on the available information. The conclusions detailed in this report are summarized below:

- Based on the details regarding recent Site activities outlined in Section 5, it is concluded that neither D&D, construction, ER, excavation, nor routine operations caused a release that resulted in the reportable Pu and Am values measured at GS10.

- Historical GS10 data suggest that actinides have been available for transport to GS10 for some time and that the recent measurements at GS10 are likely the result of legacy contamination.
- The loading analysis indicates that the South Walnut Creek reach between GS40 and GS10 is the likely origin of the majority of the Pu and Am load measured at GS10.
- Results also indicate that the average Pu/Am activity ratio for surface-water samples from GS10 is lower than that generally observed in other drainages and subdrainages across the Site. Results also indicated that the Pu/Am ratios observed at GS10 are significantly lower than those observed at monitoring locations GS27, GS28, GS38, GS39, and SW022. Although monitoring locations GS40 and GS50 show low Pu/Am ratios, these locations do not contribute significant loads to GS10. These results indicate that a source 'enriched' in Am exists within the GS10 drainage, specifically in the main South Walnut Creek reach between GS40 and GS10.
- Extensive evaluation of water-quality correlations indicate that a source term 'enriched' in Am is associated with the sediments in the main South Walnut Creek stream reach. This source term appears to affect GS10 water quality to varying degrees based on streambed erosion and resuspension rates, relative load contributions from distributed sources, and hydrologic conditions. The HRR and soil and sediment data provide information supporting this hypothesis. However, sufficient data do not exist to establish the extent and exact location of this source term.
- Surface-soil and sediment data clearly show the existence of distributed Pu and Am source terms throughout the GS10 drainage, The areas near the Solar Ponds and within the South Walnut Creek stream reach show lower Pu/Am ratios. However, sufficient data do not exist to establish the extent and exact location of the Am 'enriched' source term in the main South Walnut Creek stream reach.

WY02–03 Source Evaluation for POE GS10

The WY02–03 source evaluation for POE GS10 was completed in response to reportable water-quality values at GS10 during WY02 and WY03. This source evaluation was included in the Automated Surface-Water Monitoring Report for WY02 (the evaluation included all relevant data available as of 9/10/03). The following text is taken directly from that report describing the contents:

- Evaluation of ongoing automated surface-water monitoring within the GS10 drainage;
- Estimation of actinide loads within the GS10 drainage area;
- Evaluation of Pu/Am ratios within the GS10 drainage area; and
- A brief assessment of D&D, ER, and Site Closure projects.

The following text taken directly from that report summarizes the findings, and presents preliminary conclusions based on information presented and analyzed in that report:

> The Site is continuing the ongoing source evaluation for potential cause(s) of reportable 30-day moving average values for Pu at the POE GS10. As for previous reports, the Site concludes that the likely sources of the reportable 30-day moving average values at GS10 are:
>
> 1. Diffuse actinide contamination associated with soils and sediments from past Site operations released to the environment through events and conditions over past years. This actinide contamination is transported with suspended solids in surface-water runoff during precipitation events.

2. Actinide contamination enriched in Am that has been incorporated into the stream sediments in South Walnut Creek from past Site operations through events and conditions over past years. This actinide contamination is transported through sediment resuspension by surface-water runoff during precipitation events.

Based on the ongoing evaluation, Site personnel conclude that no specific remedial action(s) is indicated at this time, other than scheduled remedial actions and closure activities for the Site. This source investigation has identified no highly localized source(s) of contamination that warrant targeted remediation based on the available information. The current conclusions are summarized below:

- Based on the details regarding recent Site activities outlined above, it is concluded that neither D&D, construction, ER, excavation, nor routine operations caused a release that directly resulted in the recent reportable values measured at GS10.
- Historical GS10 data suggest that actinides have been available for transport to GS10 for some time and that the recent measurements at GS10 are likely the result of legacy contamination.
- The loading analysis above indicates that the South Walnut Creek reach upstream of GS10 is the likely origin of the majority of the Pu and Am load measured at GS10.
- Results shown above also indicate that the average Pu/Am activity ratio for surface-water samples from GS10 is lower than that generally observed in other drainages and subdrainages across the Site. Results also indicated that the Pu/Am ratios observed at GS10 are significantly lower than those observed at monitoring locations GS27, GS28, GS38, GS39, GS43, GS57, and SW022. Although monitoring location GS50 shows low Pu/Am ratios, this location does not contribute significant loads to GS10. These results indicate that a source relatively 'enriched' in Am exists within the GS10 drainage, specifically in the main South Walnut Creek upstream of GS10.
- Extensive evaluation of water-quality correlations in past reports indicate that a source term relatively 'enriched' in Am is associated with the sediments in the main South Walnut Creek stream reach. This source term appears to affect GS10 water quality to varying degrees based on streambed erosion and resuspension rates, relative load contributions from distributed sources, and hydrologic conditions. The HRR and soil and sediment data provide information supporting this hypothesis. However, sufficient data do not exist to establish the extent and exact location of this source term.
- Surface-soil and sediment data presented in past reports clearly show the existence of distributed Pu and Am source terms throughout the GS10 drainage. The areas near the Solar Ponds and within the South Walnut Creek stream reach show lower Pu/Am ratios. However, sufficient data do not exist to establish the extent and exact location of the Am 'enriched' source term in the main South Walnut Creek stream reach.

WY04 Source Evaluation for POE GS10

The WY04 source evaluation for POE GS10 was completed in response to reportable water-quality values at GS10 during WY04. This source evaluation was included in the *Final Source Evaluation Report for Points of Evaluation GS10, SW027, and SW093: Water Year 2004* (the evaluation included all relevant data available as of 10/6/04). The following text is taken directly from that report describing the contents:

- Evaluation of ongoing automated surface-water monitoring within the GS10 drainage;
- Estimation of actinide loads within the GS10 drainage area;
- Evaluation of water-quality trends and correlations within the GS10 drainage area;
- A brief discussion of implemented erosion controls; and
- A brief assessment of D&D, ER, and Site Closure projects.

This following text taken directly from that report summarizes the findings, and presents preliminary conclusions based on information presented and analyzed in that report:

> The Site has completed the WY04 phase of the ongoing source evaluation for the potential cause(s) of reportable 30-day moving average values for Pu and Am at the POE monitoring location GS10. As for previous reports, the Site concludes that the likely source of the reportable 30-day moving average values at GS10 is diffuse actinide contamination associated with soils and sediments from past Site operations released to the environment through events and conditions over past years. This actinide contamination is transported with suspended solids in surface-water runoff during precipitation events.
>
> Based on the above evaluation, Site personnel conclude that no specific remedial action(s) is indicated at this time, other than scheduled remedial actions and closure activities for the Site. The removal of source areas, the implementation of enhanced erosion controls, and the reduction of runoff as the Site moves toward closure all serve to improve water quality in the long-term. The surface-water monitoring conducted at the Site has provided valuable information regarding the near-term impacts to water quality to aid the Closure Projects in developing targeted methods for reducing the transport of low-level contamination. This source investigation has identified no previously unknown localized source(s) of contamination that warrant targeted remediation based on the available information. The current conclusions are summarized below:
>
> 1. The Site retention ponds continue to effectively remove suspended solids and any associated contamination from the water column. Pu and Am activities at the terminal pond and fenceline POCs remain well below reporting thresholds.
> 2. Based on the details regarding recent Site activities outlined above, it is concluded that various D&D, construction, ER, and excavation operations caused increased transport of low-level contamination associated with suspended solids in surface water that are likely to have resulted in the recent reportable values measured at GS10.
> 3. A shift in Pu/Am ratios toward a higher relative abundance of Pu at GS10 in WY04 suggest increased actinide contribution from an area with higher Pu/Am ratios, such as the 903 Pad area.
> 4. The loading analysis indicates that the GS39 subdrainage, the GS40 subdrainage, and the area directly tributary to SW022 are contributing the majority of the actinide load at GS10. Additionally, analysis shows that the Pu and Am loads from GS39 and SW022 have increased significantly in WY04. This suggests that recent projects impacting the GS39 and SW022 drainages, especially the 903 Pad remediation, have impacted water quality.

5. Pu and Am suspended solids activities at GS10 show no change in WY04. In conjunction with the increased activities at GS10, this suggests increased transport of suspended solids with contamination similar to past years, and not a significant new source term.
6. WY04 turbidities (an indication of TSS) at GS10 relative to flow rate are generally higher than for WY03 and prior data. This suggests that soils in the GS10 drainage are more susceptible to transport for a given flow rate than for previous years. Similarly, WY04 TSS data at GS10 show higher values relative to flow rate than for previous years. A similar relationship is noted for samples collected at GS39, and to a lesser extent at SW022, prior to the implementation of enhanced erosion controls. These patterns suggest that the recent higher activities at GS10 may be the result, at least in part, of the increased transport of legacy contamination associated with soil and sediment, and not any new source contribution.
7. Targeted erosion controls have proven to be effective in reducing sediment transport and associated contamination at selected locations. This is especially true for locations upstream of GS10 (nearer to the source terms) such as GS39 and SW022. No improvement is noted for GS10, most likely due to the continued transport of residual solids along the flow pathways downstream of the erosion controls. In the long-term, water quality is expected to improve at GS10 as these solids stabilize within the system, additional erosion controls are installed, source areas are removed, disturbed soils are stabilized, and runoff is reduced due to the removal of impervious areas.

WY05 Source Evaluations for POE GS10

During WY05, reportable values for Pu, Am, total uranium, and chromium were observed at GS10. Source evaluation letter reports were completed for each constituent.

This following text summarizes the findings, and presents conclusions based on information presented and analyzed in source evaluation letters (K-H, 2005c, 2005e, 2005h, 2005j, 2005l) for Pu and Am:

> *The preliminary findings and conclusions given here suggest that the GS40 sub-drainage remained as the sole contributor of significant Pu and Am load to GS10. The final actions for the GS40 sub-drainage, including the elimination of concentrated runoff, recontouring, soil stabilization, and revegetation are expected to have an immediate and positive impact to water-quality in South Walnut Creek. Recent data continue to support the conclusions of recent source evaluations that ongoing RFETS activities (i.e., Decontamination and Decommissioning and ER projects, excavations, or other routine operations) did not expose any new sources of significant contamination tributary to GS10 not being addressed by Site accelerated actions. However, significant progress towards closure has resulted in large areas of disturbed soils, resulting in increases in soil/sediment transport.*
>
> *The final actions for the GS40 sub-drainage, including the elimination of concentrated runoff, recontouring, soil stabilization, and revegetation have had an immediate and positive impact to water-quality in South Walnut Creek. Recent data continue to support the conclusions of recent source evaluations that ongoing RFETS activities (i.e., Decontamination and Decommissioning and ER projects, excavations, or other routine operations) did not expose any new sources of significant contamination tributary to GS10 not being addressed by Site accelerated actions*
>
> *In consideration of past source evaluation findings and conclusions, and the similar characteristics of this event compared to those previous, Kaiser-Hill does not believe a comprehensive search for new source contributions is warranted*

The current conclusions are summarized below:

1. The Site retention ponds continue to effectively remove suspended solids and any associated contamination from the water column. Pu and Am activities at the terminal pond and fenceline POCs remain well below reporting thresholds.
2. Based on the details regarding recent Site activities outlined above, it is concluded that various D&D, construction, ER, and excavation operations caused increased transport of low-level contamination associated with suspended solids in surface water that are likely to have resulted in the recent reportable values measured at GS10.
3. The loading analysis indicates that the GS40 subdrainage was contributing the majority of the actinide load at GS10.
4. With the physical completion of the Site, turbidities (as an indication of TSS) at GS10 relative to flow rate show a significant improvement. Targeted erosion controls have proven to be effective in reducing both sediment transport and activities at GS10. In the long-term, with the completion of the removal of impervious areas resulting in decreased runoff, the stabilization of soils within the drainage, and the progression of revegetation, water quality is expected to continue to improve.

This following text summarizes the findings, and presents conclusions based on information presented and analyzed in source evaluation letters (K-H, 2005i, 2005k) for total uranium:

> *The Site has completed the WY05 source evaluation for the potential cause(s) of reportable 30-day moving average values for total uranium at the POE monitoring location GS10. Based on the above evaluation, Site personnel conclude that the recent uranium activities at GS10 are likely a result of changing hydrologic conditions, and that no specific remedial action(s) is indicated at this time, other than scheduled remedial actions and closure activities for the Site. This source investigation has identified no previously unknown localized source(s) of contamination that warrant targeted remediation based on the available information*

The current conclusions are summarized below:

1. Data collected from all terminal pond fenceline POCs remain well below reporting thresholds for all monitored analytes.
2. Recent HR ICP/MS and TIMS analyses for both groundwater and surface-water samples collected upstream of GS10 all show a natural uranium signature. While the single analysis of surface-water from GS10 indicates the existence of some depleted uranium, the normal variability of direct runoff and groundwater flow would be expected to strongly influence the uranium characteristics, both concentration and signature, over longer periods. To fully understand this variability, additional uranium data as it relates to the appropriate water-quality action level, would need to be evaluated.
3. Groundwater data within S. Walnut Cr. Show naturally-occurring uranium activities considerably higher than the surface-water action level. Baseflow at GS10 is sustained by groundwater expressions in the form of both localized seeps and distributed flow to the streambed
4. Surface-water data from GS10 show that the higher uranium concentrations are associated with lower flow rates, during periods of extended baseflow sustained by groundwater contributions. As the impervious surface at the Site was eliminated, direct runoff to GS10 was also reduced, and groundwater contributions to S. Walnut Cr. made up a larger portion of the flows monitored at GS10. Without the mixing of uranium groundwater sources with direct surface runoff and that uranium is not readily sorbed to suspended particles, increases in surface-water uranium concentrations are expected.

DOE and the K-H Team proposed the following actions as the path forward:

- Continued observation and ongoing data interpretation (routine monitoring) to provide a better understanding of changing hydrologic and water-quality conditions at the Site;
- Continued use of HR ICP/MS and TIMS analyses, if necessary, to further understand uranium characteristics in S. Walnut Creek; and
- Continued reporting as appropriate.

This following text summarizes the findings, and presents conclusions based on information presented and analyzed in the source evaluation letters (K-H, 2005g) for total chromium:

> *The evaluation presented above suggests that ongoing RFETS activities (i.e., Decontamination and Decommissioning and ER projects, excavations, or other routine operations) did not expose any new sources of significant Cr contamination tributary to GS10. However, significant progress towards closure has resulted in large areas of disturbed soils. Data evaluation also indicates that increases in soil/sediment transport have been occurring, resulting in temporarily increased Cr concentrations at GS10 and upstream tributary locations.*

In consideration of the analysis given above, and the similar characteristics of this event compared to previous sample results, Kaiser-Hill does not believe a comprehensive search for new source contributions is warranted. Kaiser-Hill proposed the following in response to these reportable values at GS10:

- Based on interest expressed by CDPHE staff, in conjunction with discussions with DOE staff, Kaiser-Hill suggests a simple characterization for Cr VI in South Walnut Creek. An attached proposal outlined a one-time sampling event to evaluate surface-water and sediment for Cr VI in South Walnut Creek.
- Continued routine monitoring as required by RFCA and the Site Integrated Monitoring Plan. Should review of subsequent data raise issues not currently being considered, additional evaluation would be necessary.
- Continued application and maintenance of comprehensive erosion controls and revegetation measures within the areas tributary to GS10 and other drainages.

6.3.3 Summary of Completed Source Evaluations for POE SW093

WY97 Source Evaluation for Walnut Creek

The WY97 Walnut Creek Source Evaluation Reports (Reports #1, #2, #3, and Final; RMRS 1997a, 1997b, 1997c, and 1998a) included source evaluations for POC GS03 and POEs GS10 and SW093. These reports were completed in response to reportable water-quality values at these locations during WY97. The scope of the investigation for each report is summarized below.

Progress Report #1 to the Source Evaluation and Preliminary Mitigation Plan for Walnut Creek, Rev. 0 (RMRS 1997a) did not include SW093. The following text is taken directly from Progress Report #2 (RMRS 1997b) describing the contents of that report related to SW093:

- Results and analysis of ongoing RFCA monitoring;
- A detailed description of new sediment/soil sampling locations for SW093;
- A detailed description of proposed new Source Location monitoring stations for SW093;
- A summary of current AME findings with cross-links to source evaluations; and
- A summary of the status for sampling and operational modifications.

The following text is taken directly from Progress Report #3 to the Source Evaluation and Preliminary Mitigation Plan for Walnut Creek, Rev. 0 (RMRS 1997c) describing the contents of that report:

- Results and analysis of ongoing RFCA monitoring;
- An assessment of existing monitoring data for SW093;
- Updates for the new Source Location monitoring stations for SW093;
- An evaluation of the effects that watershed improvements may have had on Site water quality;
- A summary of current AME findings with cross-links to source evaluations; and
- A summary of the status for sampling and operational modifications.

The following text is taken directly from the Final Report to the Source Evaluation and Preliminary Mitigation Plan for Walnut Creek, Rev. 0 (RMRS 1998a) describing the contents of that report:

- Updates to the ongoing SW093 evaluation;
- Results and analysis of ongoing RFCA monitoring;
- An assessment and incorporation of available new data for SW093;
- Updates for the new Source Location monitoring stations for SW093;
- Hypotheses for source location(s) with supporting and non-supporting information;
- An identification of data gaps and uncertainties in the source evaluation process with suggested modifications (if any) to the AME Work Scope and the IMP;
- A summary of current AME findings with cross-links to source evaluations;
- A summary of the status for sampling and operational modifications;
- Results of the source location evaluation;
- A detailed description of identified source areas; and
- A general description of mitigating actions applicable to sources which may be identified in the future.

Taken directly from the Final Report, the following findings regarding the possible source(s) of the reportable values at SW093 were noted:

> To date, a singular source for SW093 cannot be identified. Information collected to date does not point to any singular conclusion. In fact, it is likely that multiple sources and transport mechanisms are responsible for the elevated activities at SW093. *To date, no localized areas of radiological contamination have been identified — either historical or resulting from current operations. The Site concludes that the likely source of the exceedance of the 30-day average for Pu at POE SW093 resulted from diffuse radionuclide contamination from past Site operations released to the environment through events and conditions over past years.*

The Final Report further lists the possible SW093 source(s):

- Diffuse soil and sediment contamination in the SW093 drainage, and
- A tributary surface-water source transporting contamination

WY99 Source Evaluation for POE SW093

The WY99 Source Evaluation Report for POE SW093 (RMRS 1999b) was completed in response to reportable water-quality values at SW093 during WY99. The following text is taken directly from that report describing the contents:

- Results and analysis of ongoing, automated surface-water monitoring data including trending and correlations, statistical analysis, and loading analysis;
- A review of existing soil and sediment data;
- An assessment of D&D, ER, and Site Closure projects; and
- A summary of current AME findings.

The following text taken directly from that report summarizes the findings, and presents preliminary conclusions based on information presented and analyzed in that report:

- Surface-water and soil and sediment sampling results suggest that one or more low-level distributed actinide source areas exist within the SW093 drainage. Further, surface-water activities have been of similar magnitudes for the last decade, suggesting source areas that originated as legacy contamination.
- Recent surface-water sampling results from Source Location monitoring stations have further refined the estimation of relative Pu and Am load contributions to SW093 from upstream subdrainage areas. These load estimations suggest that significant Pu and Am source terms may exist in the B779 area (GS32 subdrainage). Data indicate that these sources are legacy contamination as a result of past Site operations and are not a result of current D&D activities.
- Load estimations and soil and sediment data also suggest that Pu and Am source terms may exist in the following subdrainage areas:
  1. North Walnut Creek reach between SW118 and SW093,
  2. A portion of the 700 Area including B771/774 and B776/777,
  3. A portion of the 500 Area including B559,
  4. A portion of the 300 Area including B371/374, and
  5. A portion of the 100 Area.
- Evaluation of readings from insitu, water-quality monitoring probes indicates no unusual or unexpected conditions for WY99 to date. WY99 trends for all parameters are similar to those observed in WY98 and WY97, and real-time water-quality data cannot be linked to discrete upstream source areas.
- A review of current Site activities indicate no reason to suspect that D&D, ER Projects, excavation, or routine Site operations caused a release of Pu or Am that resulted in the elevated activities measured at SW093.
- The reportable values observed at SW093 and other monitoring locations in the SW093 drainage are not being observed at the Ponds or downstream POCs.

WY03 Source Evaluation for POE SW093

The WY03 source evaluation for POE SW093 was completed in response to reportable water-quality values at SW093 during WY03. This source evaluation was included in the Automated Surface-Water Monitoring Report for WY02 (the evaluation included all relevant data available as of 9/10/03). The following text is taken directly from that report describing the contents:

- Evaluation of ongoing automated surface-water monitoring within the SW093 drainage;
- Estimation of actinide loads within the SW093 drainage area; and
- A brief assessment of D&D, ER, and Site Closure projects.

The following text taken directly from that report summarizes the findings, and presents preliminary conclusions based on information presented and analyzed in that report:

> The findings and conclusions of this and prior Walnut Creek and SW093 source evaluations suggest that one or more low-level distributed actinide source areas exist within the SW093 subdrainage. These source evaluations and the more recent review of ongoing RFETS closure activities contained herein suggest that these upstream activities did not contribute to increased contamination and reportable values. The Tank 231A sludge spill and recent flume construction activities at SW093, with the associated sediment excavations, are the most likely cause(s) of the recent reportable values. The Site concludes that the likely sources of the reportable 30-day moving average values at SW093 are:
>
> 1. Diffuse actinide contamination associated with soils and sediments from past Site operations released to the environment through events and conditions over past years. This actinide contamination is transported with suspended solids in surface-water runoff during precipitation events,
> 2. Low-level actinide contamination associated with streambed sediments likely to have been suspended as a result of flume replacement excavations, and
> 3. Residual contamination resulting from the sludge spill from Tank 231A.
>
> Based on this evaluation, the temporary nature of the reportable values at SW093, and no impact to downstream water quality, Site personnel conclude that no specific remedial action(s) is indicated at this time, other than scheduled remedial actions and closure activities for the Site. This source investigation has identified no highly localized and persistent source(s) of contamination that warrant targeted remediation based on the available information. The conclusions detailed in this report are summarized below:
>
> - Historical SW093 data suggest that actinides have been available for transport to SW093 for some time and that the recent measurements at SW093 are likely the result of legacy contamination.
> - The loading analysis above indicates that the GS32 drainage is a significant contributor of the actinide load measured at SW093. The analysis further suggests that the recent Solar Ponds actions have not negatively impacted water quality.
> - Surface-soil and sediment data presented in previous reports clearly show the existence of low-level, distributed Pu and Am source terms throughout the SW093 drainage.

WY04 Source Evaluation for POE SW093

The WY04 source evaluation for POE SW093 was completed in response to reportable water-quality values at SW093 during WY04. This source evaluation was included in the *Final Source Evaluation Report for Points of Evaluation GS10, SW027, and SW093: Water Year 2004* (the evaluation included all relevant data available as of 10/6/04). The following text is taken directly from that report describing the contents:

- Evaluation of ongoing automated surface-water monitoring within the SW093 drainage;
- Estimation of actinide loads within the SW093 drainage area;
- Evaluation of water-quality trends and correlations within the SW093 drainage area;
- A brief discussion of implemented erosion controls; and
- A brief assessment of D&D, ER, and Site Closure projects.

The following text taken directly from that report summarizes the findings, and presents preliminary conclusions based on information presented and analyzed in that report:

> The Site has completed the WY04 phase of the ongoing source evaluation for the potential cause(s) of reportable 30-day moving average values for Pu and Am at the POE monitoring location SW093. As for previous reports, the Site concludes that the likely source of the reportable 30-day moving average values at SW093 is diffuse actinide contamination associated with soils and sediments from past Site operations released to the environment through events and conditions over past years. This actinide contamination is transported with suspended solids in surface-water runoff during precipitation events.
>
> Based on the above evaluation, Site personnel conclude that no specific remedial action(s) is indicated at this time, other than scheduled remedial actions and closure activities for the Site. The removal of source areas, the implementation of enhanced erosion controls, and the reduction of runoff as the Site moves toward Closure all serve to improve water quality in the long term. The surface-water monitoring conducted at the Site has provided valuable information regarding the near-term impacts to water quality to aid the Closure projects in developing targeted methods for reducing the transport of low-level contamination. This source investigation has identified no previously unknown localized source(s) of contamination that warrant targeted remediation based on the available information. The current conclusions are summarized below:
>
> 1. The Site retention ponds continue to effectively remove suspended solids and any associated contamination from the water column. Pu and Am activities at the terminal pond and fenceline POCs remain well below reporting thresholds.
> 2. Based on the details regarding recent Site activities outlined above, it is concluded that various D&D, construction, environmental remediation, and excavation operations caused increased transport of low-level contamination associated with suspended solids in surface water that are likely to have resulted in the recent reportable values measured at SW093. Evaluation suggests that project activities associated with IHSS Group 700-7 (GS32 subdrainage) resulted in the largest impacts to water quality at SW093.
> 3. A shift in Pu/Am ratios toward a higher relative abundance of Pu at SW093 in WY04 suggest increased actinide contribution from an area with higher Pu/Am ratios. Data from GS32 show a similar pattern.
> 4. The loading analysis indicates that the GS32 subdrainage is contributing the vast majority of the actinide load at SW093. Additionally, analysis shows that the Pu and Am loads from GS32 have

increased significantly in WY04. This suggests that recent projects impacting the GS32 drainage, especially IHSS Group 700-7, may have negatively impacted water quality.

5. Pu and Am suspended solids activities at SW093 show a significant increase in WY04. In conjunction with the increased activities at SW093, this suggests the increased contribution of a relatively more contaminated area, and/or sediment transport from a previously non-contributing area or source term. For roughly the same period, a similar pattern is noted for samples collected at GS32.

6. WY04 turbidities (an indication of TSS) at SW093 relative to flow rate are generally higher than for WY03 and prior data. This suggests that soils in the SW093 drainage are more susceptible to transport for a given flow rate than for previous years. Similarly, WY04 TSS data at SW093 show higher values relative to flow rate than for previous years. A similar relationship is noted for samples collected at GS32, prior to the implementation of enhanced erosion controls. These patterns suggest that the recent higher activities at SW093 may be the result, at least in part, to the increased transport of legacy contamination associated with soil and sediment, and not solely a new source term.

7. Targeted erosion controls have proven to be effective in reducing sediment transport and associated contamination at selected locations. This is especially true for locations upstream of SW093 (nearer to the source terms) such as GS32. No improvement is noted for SW093, most likely due to the continued transport of residual solids in the flow pathways downstream of the erosion controls. In the long-term, water quality is expected to improve at SW093 as these solids stabilize in the system, additional erosion controls are installed, source areas are removed, disturbed soils are stabilized, and runoff is reduced due to the removal of impervious areas.

WY05 Source Evaluation for POE SW093

During WY05, reportable values for Pu were observed at SW093. A source evaluation letter report (K-H, 2005d) was completed.

This following text summarizes the findings, and presents conclusions based on information presented and analyzed in the source evaluation letter for Pu:

> *The findings and conclusions of the past SW093 source evaluations suggest that low-level distributed actinide source areas exist within the SW093 sub-drainages. Significant progress towards closure has resulted in large areas of disturbed soils. Preliminary data evaluation suggests that, though no new source terms have been identified, increases in soil/sediment transport associated with Site closure activities have been occurring.*
>
> *In consideration of past source evaluation findings and conclusions, the short-term of this reportable period, and the similar characteristics of this event compared to previous solids-transport related reportable values, Kaiser-Hill does not believe a more comprehensive source evaluation is warranted. Based on the abbreviated data evaluation included herein, increased solids transport in association with functional channel construction is the probable cause of the reportable Pu values at SW093*

The current conclusions are summarized below:

1. The Site retention ponds continue to effectively remove suspended solids and any associated contamination from the water column. Pu and Am activities at the terminal pond and fenceline POCs remain well below reporting thresholds..

2. Based on the details regarding recent Site activities outlined above, it is concluded that various D&D, construction, ER, and excavation operations caused increased transport of low-level contamination associated with suspended solids in surface water that are likely to have influenced in the recent reportable values measured at SW093.
3. The data analysis indicates that the majority of the actinide load at SW093 resulted from the construction of the functional channels.
4. With the physical completion of the Site, turbidities (as an indication of TSS) at SW093 relative to flow rate show a significant improvement. Targeted erosion controls have proven to be effective in reducing both sediment transport and activities at SW093. In the long-term, with the completion of the removal of impervious areas resulting in decreased runoff, the stabilization of soils within the drainage, and the progression of revegetation, water quality is expected to continue to improve.

6.3.4 Summary of Completed Source Evaluations for POE SW027

WY98 Source Evaluation Report for Point of Evaluation SW027

The WY98 Source Evaluation Report for Point of Evaluation SW027 (RMRS 1998c) included source evaluation for POE SW027. That report was completed in response to reportable water-quality values at SW027 during WY98. The scope of the investigation for that report is summarized below.

The following text is taken directly from The WY98 Source Evaluation Report for Point of Evaluation SW027 describing the contents of that report:

- Hypotheses for source location(s) with supporting and non-supporting information, including preliminary results on source location;
- An assessment of existing monitoring data for SW027;
- Results and analysis of ongoing RFCA monitoring;
- A summary of walk-down activities and observations for SW027;
- A description of potential Source Location monitoring stations for SW027; and
- A summary of current AMS findings with cross-links to source evaluations.

Taken directly from the WY98 SW027 Report, the following findings regarding the possible source(s) of the reportable values at SW027 were noted:

> To date, only distributed contamination from the 903 Pad has been identified as a possible cause of these reportable values. Site personnel conclude that the likely source of the reportable 30-day moving averages for Pu at SW027 was diffuse radionuclide contamination from past Site operations released to the environment through events and conditions over past years, particularly from the 903 Pad. Based on the evaluation, Site personnel conclude that no specific remedial action(s) is indicated at this time, other than scheduled remedial actions for the 903 Pad, as the source investigations have identified no other localized source(s) of contamination.

WY00 Source Evaluation Report for Point of Evaluation SW027

The WY00 Source Evaluation Report for Point of Evaluation SW027 (RMRS 2001b) was completed in response to reportable water-quality values at SW027 during WY00. The following text is taken directly from that report describing the contents:

- Hypotheses for source location(s) with supporting and non-supporting information, including preliminary results on source location;
- An assessment of existing monitoring data for SW027;
- Results and analysis of ongoing RFCA monitoring;
- A summary of walk-down activities and observations for SW027; and
- An assessment of D&D, ER, and Site Closure projects.

The following text taken directly from that report summarizes the findings, and presents preliminary conclusions based on information presented and analyzed in that report:

> Site personnel conclude that the likely sources of the reportable Pu activities at SW027 are soils and sediments transported in surface-water runoff from the following areas:
>
> 1. Impervious IA subdrainage basins
> 2. Dirt roads and ditches tributary to the SID, and
> 3. Sediments within the SID channel
>
> The diffuse radionuclide contamination associated with surface-soils in the SID drainage originated as releases to the environment from Site events and conditions over past years, particularly from the 903 Pad operations. The distributed radionuclide contamination associated with sediments in the SID drainage is a result of the natural processes of soil erosion and sediment transport, deposition, and re-suspension.
>
> Based on the evaluation, Site personnel conclude that no specific remedial action(s) is indicated at this time, other than scheduled remedial actions for the 903 Pad, as the source investigations have identified no localized source(s) of contamination.

WY04 Source Evaluation for POE SW027

The WY04 source evaluation for POE SW027 was completed in response to reportable water-quality values at SW027 during WY04. This source evaluation was included in the *Final Source Evaluation Report for Points of Evaluation GS10, SW027, and SW093: Water Year 2004* (the evaluation included all relevant data available as of 10/6/04). The following text is taken directly from that report describing the contents:

- Evaluation of ongoing automated surface-water monitoring within the SW027 drainage;
- Estimation of actinide loads within the SW027 drainage area;
- Evaluation of water-quality trends and correlations within the SW027 drainage area;
- A brief discussion of implemented erosion controls; and
- A brief assessment of D&D, ER, and Site Closure projects.

The following text taken directly from that report summarizes the findings, and presents preliminary conclusions based on information presented and analyzed in that report:

> The Site has completed the WY04 phase of the ongoing source evaluation for the potential cause(s) of reportable 30-day moving average values for Pu and Am at the POE monitoring location SW027. As for previous reports, the Site concludes that the likely source of the reportable 30-day moving average values at SW027 is diffuse actinide contamination associated

with soils and sediments from past Site operations released to the environment through events and conditions over past years. This actinide contamination is transported with suspended solids in surface-water runoff during precipitation events.

Based on the above evaluation, Site personnel conclude that no specific remedial action(s) is indicated at this time, other than scheduled remedial actions and closure activities for the Site. The removal of source areas, the implementation of enhanced erosion controls, and the reduction of runoff as the Site moves toward Closure all serve to improve water-quality in the long-term. The surface-water monitoring conducted at the Site has provided valuable information regarding the near-term impacts to water quality to aid the Closure projects in developing targeted methods for reducing the transport of low-level contamination. This source investigation has identified no previously unknown localized source(s) of contamination that warrant targeted remediation based on the available information. The current conclusions are summarized below:

1. Data collected from the upcoming Pond C-2 discharge are expected to show that the Site retention ponds continue to effectively remove suspended solids and any associated contamination from the water column. Pu and Am activities at the fenceline POCs remain well below reporting thresholds.

2. Based on the details regarding recent Site activities outlined above, it is concluded that specific D&D, construction, ER, and excavation operations caused increased transport of low-level contamination associated with suspended solids in surface water that are likely to have resulted in the recent reportable values measured at SW027. Evaluation suggests that project activities associated with IHSS Group 900-11 (903 Pad/Lip) resulted in the largest impacts to water quality at SW027.

3. The loading analysis indicates that the GS51 and GS52 subdrainages are contributing the vast majority of the actinide load at SW027. Additionally, analysis shows that the Pu and Am loads from both GS51 and GS52 have increased significantly in WY04. This suggests that recent projects impacting these subdrainages, especially the 903 Pad/Lip, may have negatively impacted water quality.

4. Pu and Am suspended solids activities at SW027 show a significant increase in WY04. In conjunction with the increased activities at SW027, this suggests the increased contribution of a relatively more contaminated area, and/or solids transport from a previously non-contributing area or source term. For roughly the same period, these suspended solids activities are comparable to those at GS51 and GS52.

5. WY04 turbidities (an indication of TSS) at SW027 relative to flow rate are generally higher than for WY03 and prior data. This suggests that soils in the SW027 drainage are more susceptible to transport for a given flow rate than for previous years. Similarly, WY04 TSS data at SW027 show higher values relative to flow rate than for previous years. TSS results from both GS51 and GS52 also show unusually high values. These patterns suggest that the recent higher activities at SW027 may be the result, at least in part, to the increased transport of legacy contamination associated with soil and sediment, and not solely a new source term.

6. Comparisons of hydrologic patterns at the 903 Pad/Lip monitoring stations with excavation progress support the conclusion that remediation activities resulted in both increased runoff and increased transport of suspended solids. The comparison also suggests that BMPs are effective at

reducing both runoff and erosion. As soils stabilize and vegetation is reestablished, continued water-quality improvement is expected.

7. Targeted erosion controls have proven to be effective in reducing runoff rates and sediment transport and associated contamination at selected locations. This is especially true for locations upstream of SW027 (nearer to the source terms) such as GS51, GS52, and GS53. No improvement is noted for SW027, most likely due to the continued transport of residual solids in the flow pathways downstream of the erosion controls. In the long-term, water quality is expected to improve at SW027 as these solids stabilize in the system, additional erosion controls are installed, source areas are removed, disturbed soils are stabilized, and runoff is reduced due to the establishment of vegetation.

WY05 Source Evaluation for POE SW027

During WY05, reportable values for Pu were observed at SW027. A source evaluation letter report (K-H, 2005f) was completed.

This following text summarizes the findings, and presents conclusions based on information presented and analyzed in the source evaluation letter for Pu:

> *The Site has completed the WY05 source evaluation for the potential cause(s) of reportable 30-day moving average values for Pu at the POE monitoring location SW027. As for previous reports, the Site concludes that the likely source of the reportable 30-day moving average values at SW027 is diffuse actinide contamination associated with soils and sediments from past Site operations released to the environment through events and conditions over past years. This low-level actinide contamination is transported with suspended solids in surface-water runoff during precipitation events.*
>
> *Based on the above evaluation, Site personnel conclude that no specific remedial action(s) is indicated at this time, other than scheduled remedial actions and closure activities for the Site. The removal of source areas, the implementation of enhanced erosion controls, the stabilization/revegetation of exposed soil including dirt roads, and the reduction of runoff as the Site moves toward Closure all serve to improve water-quality in the long-term. The surface-water monitoring conducted at the Site has provided valuable information regarding the near-term impacts to water quality to aid the Closure projects in developing targeted methods for reducing the transport of low-level contamination. This source investigation has identified no previously unknown localized source(s) of contamination that warrant targeted remediation based on the available information.*

The current conclusions are summarized below:

1. The Site retention ponds continue to effectively remove suspended solids and any associated contamination from the water column. Pu and Am activities at the terminal pond and fenceline POCs remain well below reporting thresholds.

2. It is concluded that closure activities and projects have temporarily caused increased transport of low-level contamination associated with suspended solids in surface water. Evaluation suggests that project activities associated with IHSS Group 900-11 (903 Pad/Lip) resulted in the largest impacts to water quality at SW027.

3. The loading analysis indicates that the GS51 subdrainage continues to contribute the majority of the actinide load at SW027. However, analysis shows that the Pu and Am loads from GS51 continue to decrease from WY04 levels, suggesting that exposed soils continue to stabilize and revegetate in the 903 Pad/Lip area. Recent recontouring,

ripping, matting, and reseeding of areas upstream of GS51, specifically the dirt road west of the 903 Pad/Lip project area and adjacent to GS51, should further reduce transport.

4. WY05 TSS data at SW027 show a significant decrease relative to flow rate than for WY04. Targeted erosion controls have proven to be effective in reducing both sediment transport and activities at SW027. In the long-term, with the completion of the removal of impervious areas resulting in decreased runoff, the stabilization of soils within the drainage, and the progression of revegetation, water quality is expected to continue to improve.

7. AD HOC MONITORING

The Site often monitors surface waters on an *ad hoc* basis for a variety of reasons. This monitoring may be requested by DOE, RFPO, cities, agencies, building managers, and Site facility managers (e.g., the WWTP). It is anticipated that various parties will continue to request *ad hoc* monitoring in the future. This monitoring will not always require sample analyses. In some cases, only flow or continuously recorded water-quality monitoring will be needed. Examples of situations that may warrant *ad hoc* monitoring include:

- Major precipitation events that disrupt routine pond predischarge monitoring and discharge schedules;
- Community assurance monitoring at the request of downstream cities and the DOE;
- Unanticipated changes in regulatory permits, agreements, or funding;
- Special projects such as AME and Site-Wide Water Balance;
- Anticipated but unfunded changes in permits or agreements;
- Construction projects;
- Spill events; and
- Operational monitoring (i.e., footing drains, septic lift stations).

The Ad Hoc monitoring details in Section 7.1 are based on the automated Ad Hoc monitoring performed in WY05.

7.1 DATA TYPES, FREQUENCY, AND COLLECTION PROTOCOLS

The type of data collected depends exclusively on the predetermined intent of the specific Ad Hoc monitoring location. The collected data can then be processed to provide decision support or input to a technical analysis. In most cases, flow is the primary data collected.

7.2 WY05 MONITORING SCOPE

Table 7-1 lists the Ad Hoc monitoring locations that were operational during WY05. Figure 2-1 shows the location of these monitoring stations.

Table 7-1. Ad Hoc Monitoring Locations.

Location Code	Location	Primary Flow Measurement Device	Telemetry	Notes
B371BAS	Building 371 basement footing drain	11.4° V-Notch Weir	Yes	Data collection to confirm proper operation of footing drain systems
B371SUBBAS	Building 371 sub-basement footing drain	11.4° V-Notch Weir	Yes	Data collection to confirm proper operation of footing drain systems
GS33	No Name Gulch at confluence with Walnut Creek	9.5" Parshall Flume	Yes	Data collection for Site-Wide Water Balance

Note: Only locations specifically installed in support of an Ad Hoc project are shown.

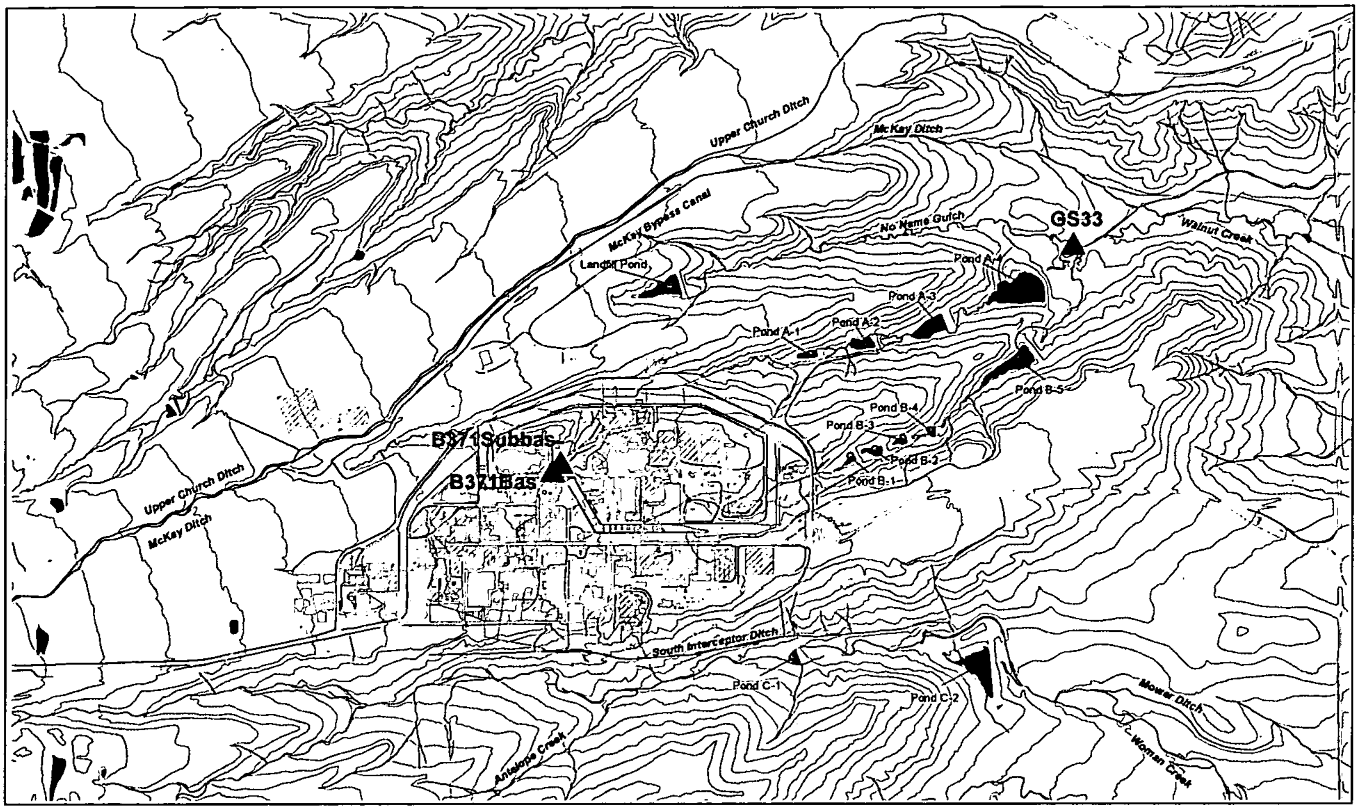

Figure 7-1. WY05 AdHoc Monitoring Locations.

Table 7-2. Ad Hoc Field Data Collection: Parameters and Frequency.

Location Code	Parameter
	Discharge
B371BAS	hourly averages of 1-min. measurements
B371SUBBAS	hourly averages of 1-min. measurements
GS33	15-min continuous

Note: Only locations specifically installed in support of an Ad Hoc project are shown.

7.3 DATA EVALUATION

7.3.1 Building 371 Footing Drain Monitoring Locations

Operation of B371BAS and B371SUBBAS provides real-time data confirming the proper operation of the B371 footing drain systems. B371 personnel are notified of a no-flow or high-flow condition, which would initiate investigation of those systems. Telemetry has been made available to B371 personnel to allow for direct tracking of footing drain operation and for the monthly building surveillance activity. Flow data are not given in this report. Data can be found in Appendix 1 of the *Building 371 Subsurface Drain System* procedure (4-K14-SDS-371). Sample collection is not performed at these locations.

7.3.2 Site-Wide Water Balance Flow Measurement Locations

Monitoring location GS33 was operated to specifically collect flow data in support of the Site-Wide Water Balance Project. Flow data from this location will be applied to configuration and calibration of the model. Flow and precipitation data from other monitoring locations at the Site are also used by this project. These locations are described under the other decision rules included in this report. Flow data are summarized in Section 3 Hydrologic Data; more detailed flow data are included in Appendix A.1 Discharge Data.

8. INDICATOR PARAMETER MONITORING FOR ASSESSMENT OF ANALYTICAL WATER-QUALITY DATA

This objective provides the justification for the collection of general water-quality and quantity information to be used for various data assessments. Specifically, this objective outlines the current and expected uses of parameters such as TSS, turbidity, and flow rate.

This monitoring objective is intended to establish relationships between analytical measurements of constituents such as actinides and metals with selected indicator parameters, such as TSS, turbidity, precipitation, and flow rate. The determination of these relationships will support evaluation of erosion control measures, design of final Site land configuration options, future pond operations, investigations into actinide transport, assessment of statistically significant changes in water quality, and management decision making. Table 8-3 provides a listing of data uses for this monitoring objective.

8.1 DATA TYPES, FREQUENCY, AND COLLECTION PROTOCOLS

To evaluate the relationship between TSS and analytical constituents[37], TSS would ideally be analyzed for all samples collected at the locations covered by the other decision rules in this report. However, sampling protocols (continuous flow paced) often result in composite samples that are collected over periods exceeding the 7-day hold time for TSS analyses. Therefore, TSS cannot be analyzed for all composite samples but will be analyzed whenever hold time requirements are met.

To evaluate the relationship between turbidity and analytical constituents, turbidity will be monitored at the locations where required by the other applicable decision rules. These locations include POEs (GS10, SW093, and SW027) and terminal pond POCs (GS08, GS11, and GS31). Each of these stations is equipped with a real-time, water-quality probe to continuously monitor turbidity.

To evaluate the relationship between precipitation and analytical constituents, precipitation is currently monitored at 12 locations across the Site. The location of precipitation gages allows for the calculation of areal precipitation for any drainage area tributary to each monitoring location. Each of these locations is equipped with a continuously recording precipitation gage.

To evaluate the relationship between flow rate and analytical constituents, flow is currently measured at almost all monitoring locations across the Site. Each of these locations is equipped with continuously-recording flow-measurement instrumentation. Some locations do not collect flow data due to specific water routing configuration limitations. However, flow can be estimated for these locations using flow from comparable locations, runoff coefficients, and subdrainage area.

This decision rule does not limit the data uses to those given in Table 8-3. Relationships can be determined for any data combinations as required. For example, relationships between flow and precipitation, turbidity and TSS, precipitation and TSS, etc. may be useful depending on the specific data evaluation.

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[37] The term 'analytical constituents' is used here to refer to constituents measured for samples collected as defined by the other decision rules in this report.

8.2 WY05 MONITORING SCOPE

The following tables detail the Indicator Parameter monitoring scope for WY05. Figure 8-1 shows the Indicator Parameter monitoring locations.

Table 8-1. Indicator Parameter Data Collection: Parameters and Frequency.

Parameter	Frequency	Monitoring Location(s)
Turbidity[a]	15-min continuous	GS08, GS10, GS11, GS31, SW027, and SW093
Flow rate	5-min continuous	All locations where feasible
Precipitation	5-min continuous	13 locations site-wide
Flow volume	Derived from flow rate for any selected time period	All locations where feasible

Notes: [a] Turbidity is collected using real-time water-quality probes. These probes can not handle winter icing conditions without being damaged. Therefore, these probes collect data whenever possible, and data collection may not be possible for significant periods during the winter.

Table 8-2. Analytical Data Collection: Analytes and Frequency.

Analyte	Frequency	Monitoring Location(s)
Radionuclides	Determined by applicable monitoring objective	All locations as applicable
TSS	Determined by applicable monitoring objective; all samples that meet TSS hold time limits	All locations as applicable

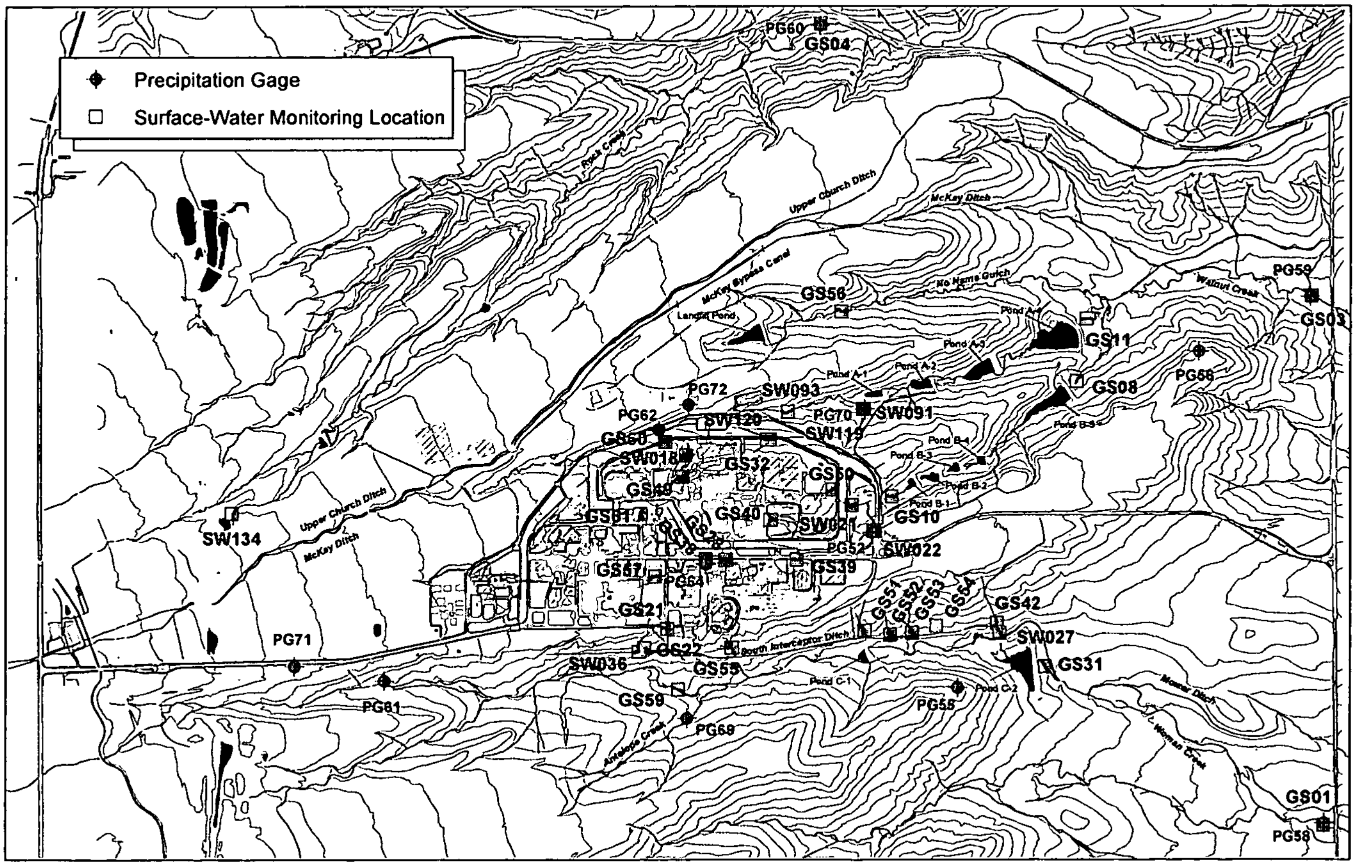

Figure 8-1. WY05 Indicator Parameter Monitoring Locations.

Table 8-3 outlines the past data uses associated with this decision rule. The data uses listed in **bold** were included in this section in previous annual reports. Other data uses were included in Source Evaluation reports (see Section 6) or in reports from other Site projects. Previous data evaluation under this decision rule was intended to provide information that the Site used to understand transport processes to protect water quality during active closure activities. With the Site being declared physically complete, rigorous data evaluation under this objective is no longer needed, and evaluation is not included in this WY05 report. Water-quality probe data are presented in other sections of this report, and are also provided in the appendices along with the analytical data.

Table 8-3. Selected Data Uses of Indicator Parameter Monitoring for Analytical Water-Quality Assessment.

Data Use	Required Parameters	Description
Correlation of Actinides with TSS	**Actinides, TSS**	**Use of TSS measurements to predict actinide concentrations**
Correlation of Actinides with Turbidity	**Actinides, turbidity**	**Use of turbidity measurements to predict actinide concentrations**
Correlation of Radionuclides with Flow Rate	**Radionuclides, flow rate**	**Use of flow rate measurements to predict radionuclides concentrations**
Correlation of TSS with Turbidity	**TSS, turbidity**	**Use of turbidity measurements to predict TSS concentrations**
Correlation of TSS and Turbidity with Flow Rate	**TSS, turbidity, flow rate**	**Use of flow rate measurements to predict TSS concentrations and turbidity**

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9. PERFORMANCE MONITORING

This section addresses monitoring the performance of specific actions[38] on Site for the release of contaminants to the environment. Project-specific Performance monitoring may have been specified in the project plan through the review and approval process for those projects which pose a concern for a contaminant release, especially for a contaminant that may not be adequately monitored by other monitoring objectives downstream. Each Performance monitoring location targeted contaminants of the greatest concern for the specific action being monitored. For example, Performance monitoring for specific analytes may have been needed for the evaluation of the following:

- Building D&D Activities: The review and approval process for a D&D action may identify the need for Performance monitoring specific to that action.
- Accelerated Actions: Specific monitoring requirements may be identified for specific ER activities. For example, Performance monitoring for RFETS's operating groundwater plume treatment systems is specified in the related work plans (i.e., *Final Mound Site Plume Decision Document, Final Proposed Action Memorandum for the East Trenches Plume*, and *Final Solar Ponds Plume Decision Document*).
- Other Closure Activities: Specific Performance monitoring may be needed for certain activities if other monitoring described in the IMP fails to provide adequate assurance of protecting the environment and public health.
- Off Normal Conditions: Monitoring of remedies intended to control contaminant transport in surface-water runoff may be required. For example, when a BMP (barrier, trap, filter, or other watershed improvement) is installed to control a potential source of contaminated runoff, RFETS would like to determine the BMP effectiveness so that resources may be allocated where they are most effective.

Monitoring of activities within the IA was achieved, in general, through NSD and POE monitoring (see Sections 10 and 11 for details) at the IA boundary. Project-specific Performance monitoring stations monitored specific Site activities, such as D&D of a particular building or building cluster. These mobile, temporary stations were placed upstream from the routine monitoring stations (POE and NSD), closer to specific projects/activities to monitor a specific subdrainage for releases of contaminants associated with the activity in the subdrainage.

9.1 DATA TYPES, FREQUENCY, AND COLLECTION PROTOCOLS

Analyte suites (data types for collection) were generally determined by the contaminants of concern associated with a specific activity. Generally, automated samples were continuous flow-paced composites. However, protocols may have been modified depending on the specific conditions for a monitoring location or drainage basin. Regardless, the sampling protocols were designed to accurately characterize existing flows, and confidently monitor changes during the project activities.

Generally, monitoring was initiated prior to the start of project activities such that 10 - 15 samples over varying flow rates could be collected (preferably 18 months prior to project initiation[39]). Results from these samples were used to establish a baseline for the subdrainage. Monitoring continued during the activity, attempting to collect one sample per month. After project completion, monitoring is continued approximately 3 months to determine any impacts (both positive and negative) to surface-water quality. Performance monitoring occurred anywhere within the Site surface-water drainage area (especially within the IA), downstream from a BMP, remediation, or closure activity.

[38] This is project-specific, versus the global monitoring (NSD and POE) of the IA discussed in Sections 0 and 11.

[39] Due to the dynamic nature of Site Cleanup, initiation of Performance monitoring 18 months prior to an activity is rarely achieved. However, additional samples are often collected at an increased rate to establish baseline prior to initiation of project activities.

9.2 WY05 MONITORING SCOPE

Table 9-1. Performance Monitoring Locations.

Location Code	Location	Primary Device	Telemetry	Project [Project Contact]
GS21	Culvert SE of B664	1.0' H-Flume	Yes	B664 D&D; [Contact: M. Francis, x2358]
GS22	Outfall to SID draining 400 Area	1.5' H-Flume	Yes	400 Area D&D activities; [Contact: K. Oman, x7129]
GS28	Small ditch NW of B865	3" Parshall Flume	Yes	B883 and B865 D&D activities; [Contact: M. Shafer, x4375]
GS32	Corrugated metal pipe (1.5') north of Solar Ponds in PA draining B779 area	18" cmp[a]	Yes	D&D of B779 and B776/777; [Contacts: R. Lesser, x2298, B776/777]
GS38	Central Avenue Ditch east of 8th Street	9.5" Parshall Flume	Yes	Closure activities for 100, 300, 400, and 600 Areas [Contacts: NA]
GS39	Corrugated metal pipe (1.0') north of 904 Pad draining 903/904 Pads and Contractor Yard areas	1' H Flume	Yes	Accelerated actions for 903 Pad; [Contact: T. Spence, x4322]
GS40	Drainage Ditch in PA east of Tenth St. (750 Pad) south of Building 997	1' Parshall Flume	Yes	B707 area D&D activities; [Contact: R. Lesser, x2298]
GS42	Gulch tributary to SID 150' above POE SW027	3" Parshall Flume	Yes	Accelerated actions for 903 Pad; [Contact: T. Spence, x4322]
GS49	Ditch NW of B566	6" Parshall Flume	Yes	D&D of B776/777; [Contact: R. Lesser, x2298, B776/777]
GS50	Ditch north of B990	6" Parshall Flume	Yes	Solar Ponds accelerated actions; [Contact: T. Lindsay, x5705, Solar Ponds]
GS51	Ditch along abandoned road south of 903 Pad just upstream of SID	0.75' H-Flume	Yes	Accelerated actions for 903 Pad; [Contact: T. Spence, x4322]
GS52	Gully SSE of 903 Pad just upstream of SID	0.6' HS-Flume	No	Accelerated actions for 903 Pad; [Contact: T. Spence, x4322]
GS53	Gully SE of 903 Pad just upstream of SID	0.6' HS-Flume	No	Accelerated actions for 903 Pad; [Contact: T. Spence, x4322]
GS54	Gully ESE of 903 Pad just upstream of SID	0.6' HS-Flume	No	Accelerated actions for 903 Pad; [Contact: T. Spence, x4322]
GS55	Outfall to SID draining B881 area	120° V-Notch Weir	Yes	B881 and B883 D&D activities; [Contacts: C. Albin, x5164, B881; M. Shafer, x4375, B883]
GS56	No Name Gulch below Landfill Pond	9" Parshall Flume	Yes	Present Landfill remediation activities; [Contact: T. Lindsay, x5705]
GS57	Ditch NE of B444 area	9.5" Parshall Flume	Yes	B444 and 400 Area D&D activities; [Contact: K. Oman, x7129]
GS59	Woman Creek 900ft upstream of Antelope Springs confluence	1.5' Parshall Flume	Yes	Original Landfill accelerated actions; [Contact: T. Lindsay, x5705]
GS60	Ditch NE of B371 along former PA perimeter road	6" Parshall Flume	Yes	B371/374 D&D activities; [Contact: B371 CCA, x5385]
GS61	Ditch west of 231 Tanks	9" Montana Flume	Yes	B371/374 D&D activities; [Contact: B371 CCA, x5385]
SW018	N. Walnut Cr. tributary S of 771 trailers	1' Parshall Flume	Yes	B371/374 D&D activities; [Contact: B371 CCA, x5385]

Location Code	Location	Primary Device	Telemetry	Project [Project Contact]
SW021	Concrete pipe draining area around B991	1.5' H-Flume	Yes	B991 D&D; [Contact: B991 CCA]
SW036	SID downstream of Original Landfill	6" Parshall flume	Yes	Original Landfill remediation activities; [Contact: T. Lindsay, x5705]
SW091	Downstream end of gully at confluence with N. Walnut Cr. draining NE Solar Ponds area	6" Cutthroat Flume	Yes	Solar Ponds accelerated actions; [Contact: T. Lindsay, x5705, Solar Ponds]
SW119	Drainage ditch north of Solar Ponds along PA perimeter road	9" Parshall Flume	Yes	Solar Ponds accelerated actions; [Contact: T. Lindsay, x5705, Solar Ponds]
SW120	Drainage ditch north of Solar Ponds along PA perimeter road	4" Cutthroat Flume	Yes	B771/774 D&D and Solar Ponds accelerated actions; [Contact: T. Lindsay, x5705, Solar Ponds; C. Gilbreath, x7355, B771/774]

Notes: [a] Due to the current configuration of in place stormwater culverts, flow measurement at this location is not possible without significant construction modifications. All other locations collect 5- and 15-minute flow data.

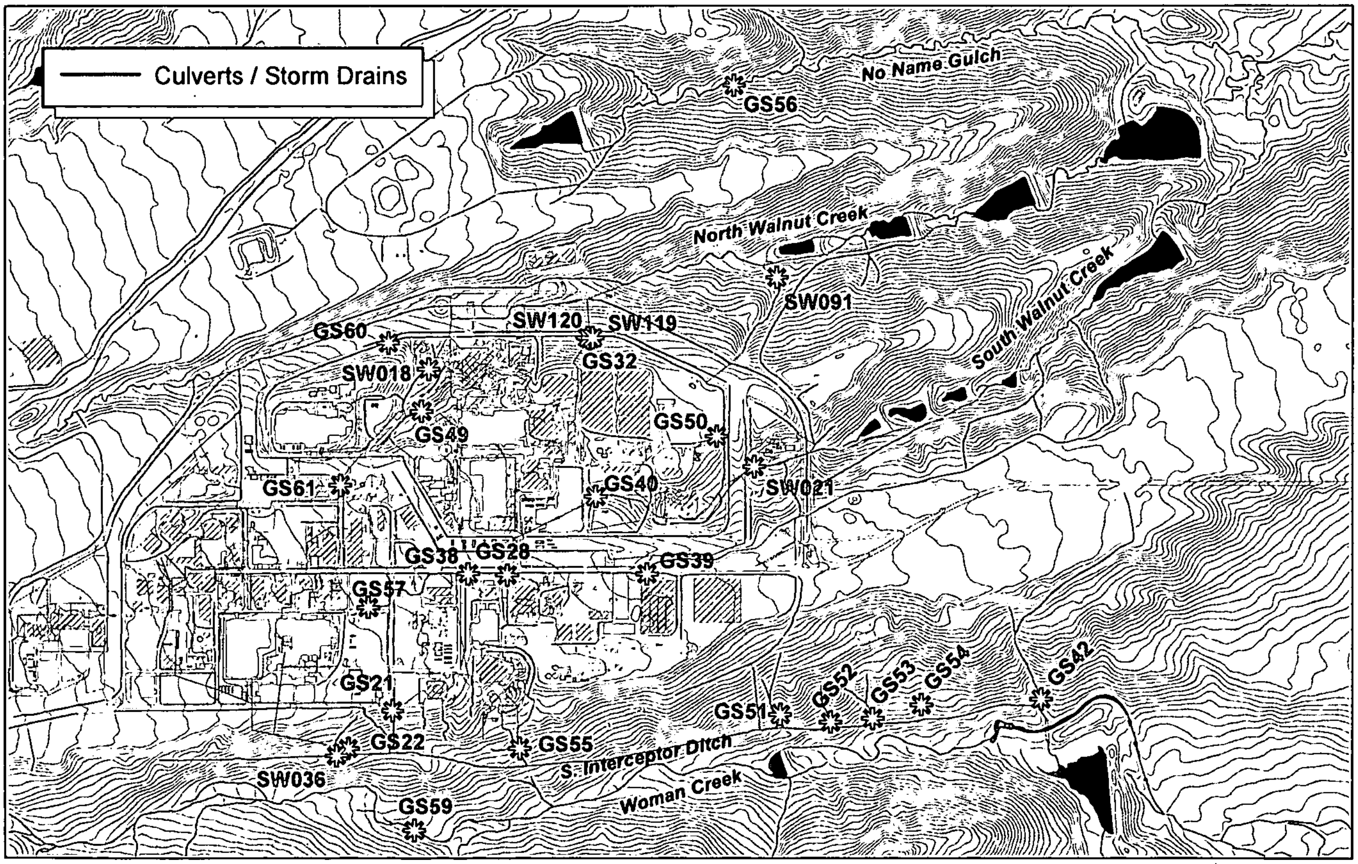

Figure 9-1. WY05 Performance Monitoring Locations.

Table 9-2. Performance Sample Collection Protocols.

Location Code	Frequency: WY05 Actual (Target)	Type[a]
GS21	6 (11 per year[a]); discontinued 6/30/05	Continuous flow-paced composites
GS22	5 (4 per year[a]); discontinued 3/24/05	Continuous flow-paced composites
GS28	4 (8 per year[c]); discontinued 5/3/05	Continuous flow-paced composites
GS32	3 (1 per month[c]); discontinued 3/1/05	Storm-event rising-limb time-paced composites[c]
GS38	9 (9 per year[a]); discontinued 6/6/05	Continuous flow-paced composites
GS39	8 (7 per year[a]); discontinued 5/17/05	Continuous flow-paced composites
GS40	17 (17 per year[a]); discontinued 8/3/05	Continuous flow-paced composites
GS42	3 (2 per year[c]); discontinued 9/7/05	Continuous flow-paced composites
GS49	12 (17 per year[a]); discontinued 8/30/05	Continuous flow-paced composites
GS50	2 (0 per year[c]); discontinued 3/22/05	Continuous flow-paced composites
GS51	9 (10 per year[c])	Continuous flow-paced composites
GS52	8 (11 per year[c]); discontinued 9/7/05	Continuous flow-paced composites
GS53	1 (9 per year[c]); discontinued 9/7/05	Continuous flow-paced composites
GS54	5 (1 per year[c]); discontinued 9/7/05	Continuous flow-paced composites
GS55	6 (11 per year[a]); discontinued 9/12/05	Continuous flow-paced composites
GS56	15 (17 per year[a]); discontinued 7/18/05	Continuous flow-paced composites
GS57	15 (17 per year[a]); discontinued 7/18/05	Continuous flow-paced composites
GS59	10 (11 per year[b])	Continuous flow-paced composites
GS60	11 (13 per year[a]); discontinued 7/21/05	Continuous flow-paced composites
GS61	10 (9 per year[a]); discontinued 8/22/05	Continuous flow-paced composites
SW018	21 (20 per year[a])	Continuous flow-paced composites
SW021	2 (2 per year[a]); discontinued 12/6/04	Continuous flow-paced composites
SW036	3 (0 per year[c]); discontinued 3/17/05	Continuous flow-paced composites
SW091	3 (1 per month)	Storm-event rising-limb flow-paced composites[c]
SW119	2 (0 per year[a]); discontinued 3/1/05	Continuous flow-paced composites
SW120	2 (0 per year[a]); discontinued 3/15/05	Continuous flow-paced composites

Notes: [a] Sample types are defined in Appendix B.
[b] *Annual total samples is 12 per year. Frequency of collection is based on expected flow volumes such that each sample collects water* representing similar stream discharge volumes; for example, more samples are collected in wet spring months than dry winter months.
[c] Storm-event sampling at locations which are often dry and normally only receive direct runoff is opportunistic. Some locations may see flow only during wet months. Every attempt is made to achieve the target sample frequency; however, this is not always possible.

Table 9-3. Performance Analytical Targets (Analyses per Year).

Location Code	TSS[a]: WY05 Actual (Target)	Pu, U, Am: WY05 Actual (Target)	CLP Metals: WY05 Actual (Target)
GS21	0 (11)	6 (11)	NA
GS22	0 (4)	5 (4)	5 (4)
GS28	0 (8)	4 (8)	4 (8)
GS32	3 (1)	3 (1)	3 (1)
GS38	1 (9)	9 (9)	9 (9)
GS39	3 (7)	8 (7)	NA
GS40	1 (17)	17 (17)	17 (17)
GS42	2 (2)	3 (2)	NA
GS49	4 (17)	12 (17)	12 (17)
GS50	0 (0)	2 (0)	2 (0)
GS51	4 (10)	9 (10)	NA
GS52	5 (11)	8 (11)	NA
GS53	0 (9)	1 (9)	NA
GS54	5 (1)	5 (1)	NA
GS55	1 (11)	6 (11)	6 (11)
GS56	4 (11)	11 (11)	11 (11)

Location Code	TSS[a]: WY05 Actual (Target)	Pu, U, Am: WY05 Actual (Target)	CLP Metals: WY05 Actual (Target)
GS57	6 (17)	15 (17)	15 (17)
GS59	4 (11)	10 (11)	10 (11)
GS60	2 (13)	11 (13)	11 (13)
GS61	2 (9)	10 (9)	10 (9)
SW018	4 (20)	21 (20)	21 (20)
SW021	0 (2)	2 (2)	2 (2)
SW036	0 (0)	3 (0)	3 (0)
SW091	3 (12)	3 (12)	3 (12)
SW119	2 (0)	2 (0)	2 (0)
SW120	1 (0)	1 (0)	1 (0)

Notes: [a] Ideally, TSS would be analyzed for all samples collected at the above locations. However, continuous flow-paced sampling protocols often result in composite samples which are collected over periods exceeding the 7-day hold time for TSS analyses. Therefore, TSS can not be analyzed for all continuous flow-paced composite samples, but will be analyzed when possible.

Previous data evaluation under this decision rule was intended to provide information to Site projects used to evaluate the effectiveness of engineering controls to protect water quality during active closure activities. With the Site being declared physically complete, rigorous data evaluation under this objective is no longer needed, and evaluation is not included in this WY05 report. Generally, evaluation was performed as data became available, especially if an initial qualitative screening based on process knowledge indicates that an analytical result is higher than normal for a particular location.

Analytical data are presented in other sections of this report, and are also provided in the appendices.

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10. NEW SOURCE DETECTION MONITORING

The NSD monitoring objective provides comprehensive coverage of the entire IA but is not specifically focused on individual actions within the IA. Performance monitoring of specific activities within the IA (or elsewhere) may be carried out under the Performance monitoring objective. This NSD objective monitors the performance of all remedial activities within the IA with respect to their impact on surface waters. However, it does not necessarily identify and locate a specific source within the IA[40]. This monitoring objective provides for monitoring of all main drainages from the IA into the three main channels of Stream Segment 5.

10.1 DATA TYPES, FREQUENCY, AND COLLECTION PROTOCOLS

This objective requires contaminant concentration data from surface-water samples taken at permanent monitoring locations located on the five main surface-water pathways to the Site retention ponds. Analyses are performed for each of the contaminants and parameters listed below to establish a baseline. After a baseline has been established, evaluations are performed as required by the decision rules. The basis for selecting these contaminants of concern and indicator parameters is described below.

- Pu, U, and Am are primary contaminants of concern to the regulators and the public.
- Turbidity, pH, nitrate (NO_3^-), and conductivity are analyses performed continuously because they are inexpensive and can be used as real-time indicators to provide or negate reasonable cause to analyze for other specific contaminants.
- Turbidity may indicate increased contaminant loads in general and increased Pu specifically. (Pu in surface water is generally bound to particulates).
- pH can be used to detect an acid or caustic spill.
- Nitrate can be used in real-time to detect chemical spills that include Pu nitrate.
- Conductivity can be used to corroborate a pH reading and to detect salt solution spills or significant concentrations of ionic contaminants.
- Precipitation data are used to determine whether a flow event results from rain or snowmelt runoff, an operational discharge[41], or a spill. Precipitation data are collected at 12 locations across the Site. From these, effective precipitation for a given monitoring location drainage can be calculated.
- Water flow rate is used to identify an event, trigger an automatic sampler, control the flow-paced sampling, and evaluate the magnitude of the spill or contaminant source (mass loading).
- Small changes to apparent base flow not attributable to rain and snow melt, or unusual runoff hydrograph shapes, may indicate a spill or operational discharge.

This monitoring objective is limited to information collected at the IA boundary, as represented by surface-water monitoring stations SW022, SW091, SW093, SW027, and GS10[42] (see Figure 10-1). This monitoring focuses on runoff into the three main drainage areas leaving the IA: North Walnut Creek, South Walnut Creek, and the SID / Pond C-2 drainage (see Figure 2-4). SW022 waters are normally monitored subsequently at GS10, so there is some redundancy in these of monitoring stations. SW022 has been included at the request of the EPA to provide increased sensitivity for its drainage area. Data from SW022 can also be used to aid the location of any new source detected at GS10.

[40] Location of a specific source would be performed under the Source Location monitoring objective described in Section 6.

[41] An operational discharge can be defined as a footing drain or sump discharged to ground, incidental water discharged to ground, spray water used for dust suppression during D&D, fire hydrant testing, a utility line break, etc.

[42] Subdrainage monitoring stations within the IA are used for Performance monitoring and source location but are excluded from the planned monitoring for this NSD decision rule.

For SW022 (10/1/96 – 9/30/99) and SW091, sampling is event-specific, focused on the time period during which the first-flush conditions prevail; specifically, during the rising limb of a direct runoff hydrograph after any storm event.[43] Starting on 10/1/99, SW022 began collecting continuous flow-paced composite samples. For SW093, GS10, and SW027, the analytical data used for the NSD objective will be the same data as collected from the continuous flow-paced sampling used for monitoring Segment 5 Action Level compliance (see Section 11).

Only surface-water runoff from the IA is included, (i.e., baseflow, stormwater runoff flow, operational discharges, and spills to surface water). Spills are only included in this NSD monitoring as a secondary monitoring objective if an increase in flow rate is detected and cannot be attributed to precipitation runoff or other identified discharge. However, other administrative and management controls address the monitoring for spills as a primary objective. Three of these NSD locations also provide confirmation that containment measures for spills or accidental discharges have been effective through monitoring of the real-time indicator parameters.[44]

Indicator monitoring will be performed for the parameters specified at the top of each column of Table 10-1. The first three columns are AoIs monitored directly through sample analytical measurements. Although these three columns and rows have a different relationship than the others, they have been included so that all monitored parameters are shown on the same table. The remaining columns are indicator parameters that are monitored with inexpensive real-time probes in lieu of analyzing for the AoIs identified at the left of each row.

Table 10-1. Screening for New Source Detection: AoIs vs. Indicator Parameters.

	Routinely Monitored Parameters							
	Monitored AoIs			Indicator Parameters for AoIs				
AoIs	**Pu**	**U**	**Am**	**Turbidity**	**pH**	**Conductivity**	**Nitrate**	**Flow Rate; Precipitation[a]**
Plutonium	X			X			X	X
Uranium		X						X
Americium			X	X				X
Turbidity				X				X
pH					X		X	X
Conductivity						X		X
Nitrate						X	X	X
Chromium					X	X	X	X
Beryllium						X		X
Silver						X		X
Cadmium						X	X	X

Notes: [a] Precipitation data are collected at site-wide locations. Precipitation data collection is not required at each NSD location, but site-wide data are used for NSD evaluation.

[43] Descriptions of sample collection protocols are given in the Appendices.

[44] Real-time indicator measurement at SW022 and SW091 has proven impractical due to the ephemeral nature of the flow at these locations. The real-time water quality probes require that their sensors remain wet at all times. Since these locations are dry except during periods of direct runoff, the Site has historically employed 'sump' systems that use tap water to keep the sensors wet. These systems were designed to flush during direct runoff so that the tap water was replaced by runoff water. However, the relatively slow response time of the sensors often resulted in data that was poor or unusable. These sump systems were also susceptible to freezing during cold weather, which occasionally resulted in damage to the equipment. For these reasons, the Site has very limited real-time indicator data for SW022 and SW091, and water-quality probes are not routinely deployed at these locations.

10.2 WY05 MONITORING SCOPE

Table 10-2. New Source Detection Monitoring Locations.

Location Code	Location	Primary Flow Measurement Device	Telemetry
SW093	N. Walnut Cr. 1300' upstream from the A-1 Bypass	36" Suppressed Rectangular Sharp-Crested Weir; 3' H-Flume installed 5/29/03	Yes
SW091	Gully NE of Solar Ponds outside inner fence	6" Cutthroat Flume	Yes
GS10	S. Walnut Cr. upstream from the B-1 Bypass	9" Parshall Flume	Yes
SW022	Central Avenue Ditch at inner east fence	9.5" Parshall Flume	Yes
SW027	SID just upstream of Pond C-2	Dual Parallel 120° V-Notch Weirs	Yes

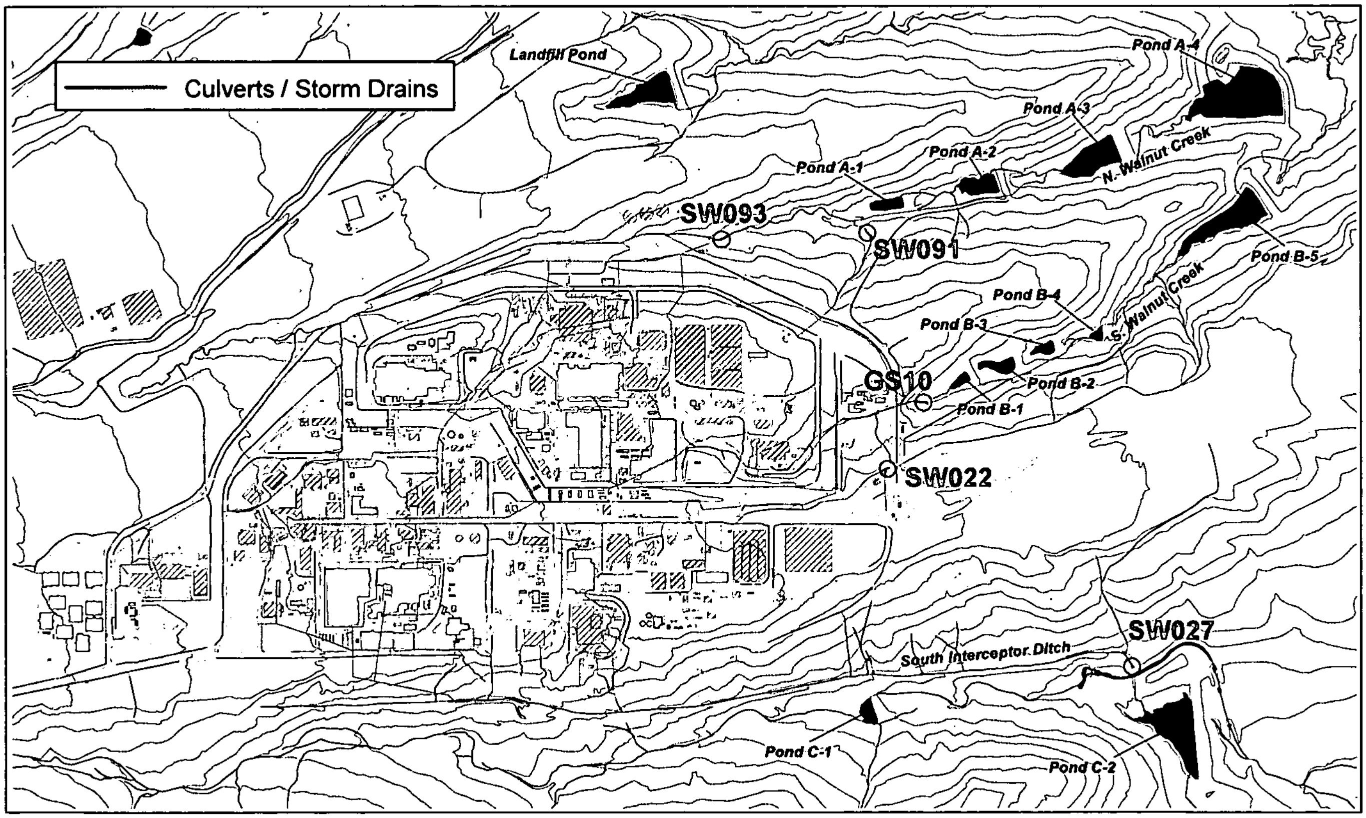

Figure 10-1. WY05 New Source Detection Monitoring Locations.

Table 10-3. New Source Detection Field Data Collection: Parameters and Frequency.

	Parameter		
Location Code	**Discharge**	**Real-Time pH, Conductivity, Turbidity, Nitrate**	**Precipitation**
SW093	15-min continuous	15-min continuous	NA
SW091	15-min continuous	See footnote 44	5-min continuous
GS10	15-min continuous	15-min continuous	NA
SW022	15-min continuous	See footnote 44	5-min continuous
SW027	15-min continuous	15-min continuous	NA

Table 10-4. New Source Detection Sample Collection Protocols.

Location Code	Frequency[a]: WY05 Actual (Target)	Type[b]
SW093	27 (12 per year[c])	Continuous flow-paced composites
SW091	3 (1 per month[d]); discontinued 9/7/05	Storm-event rising-limb flow-paced composites
GS10	28 (12 per year[c])	Continuous flow-paced composites
SW022	5 (12 per year[c]); discontinued 4/17/05	Continuous flow-paced composites (10/1/99 - Present)
SW027	8 (12 per year[c])	Continuous flow-paced composites

Notes: [a] Only SW091 is sampled on the rising limb of the hydrograph, as originally specified for this decision rule. Stations SW093, SW027, and GS10 are the Segment 5 Action Level (POE) monitoring stations (see Section 11). At these Segment 5 stations, NSD is performed by statistically testing the continuous flow-paced sample results required for the POE objective. The same test criterion is used, except that continuous flow-paced samples are tested against flow-paced variability. These locations collect more than the target 12 samples for the NSD objective. All results collected at these locations under the POE objective are used in the NSD objective.

[b] Sample types are defined in Appendix B.

[c] Sample frequency distribution during the year for SW093, GS10, and SW027 (POEs) is given in Section 11.

[d] Storm-event sampling at locations which are often dry and normally only receive direct runoff is opportunistic. These locations may see flow only during wet months. Every attempt is made to achieve the target sample frequency; however, this is not always possible.

Table 10-5. New Source Detection Analytical Targets (Analyses per Year).

Location Code	Pu, U, Am: WY05 Actual (Target)
SW093[a]	27 (12)
SW091	3 (12)
GS10[a]	28 (12)
SW022	5 (12)
SW027[a]	8 (12)

10.3 DATA EVALUATION

Indicator monitoring is performed for the parameters specified in Table 10-1. The first three columns are AoIs monitored directly through sample analytical measurements. The remaining columns are indicator parameters that are monitored with real-time probes in lieu of analyzing the AoIs. If a significant increase is detected in any one of these indicator parameters, then there is reasonable cause to suspect the presence of the AoI. For example, if the nitrate probe detects a high nitrate concentration, then the Site would have reasonable cause to suspect the presence of Pu nitrate, extreme pH, cadmium nitrate, and, of course, high nitrate, all of which are AoIs for Segment 5. If there were reasonable cause to suspect the presence of these AoIs, then the Site would perform additional analyses specific for the AoIs.

Data collected by water-quality probes at NSD locations are considered and evaluated, at a minimum, in the following ways:

- Daily average values are checked qualitatively (daily on work days) using the radio telemetry equipment.
- A general qualitative evaluation of data is performed (generally monthly).
- A detailed work-up of 15-minute data is generated and archived (generally monthly), and
- A detailed work-up and evaluation of daily averages is completed and archived (generally monthly).

Each of these data evaluation activities is completed for all water-quality parameters measured by the probes. Additional evaluation may be performed for a variety of reasons including spill investigations, special requests, and studies of probe performance. The above listed data evaluation activities are described individually, in greater detail in Appendix B.5: Real-Time Water-Quality Parameters. Due to the relatively high error associated with the nitrate sensor readings (see footnote in Appendix B.5.1), nitrate data are not presented in this section.

Nitrate data are presented in Appendix B.5.2 for reference. Plots of the other mean daily water-quality parameter values are given below. Detailed data for all parameters are presented in Appendix B.5.2.

Generally, analytical data evaluation is performed as data become available, especially if an initial qualitative screening based on process knowledge indicates that an analytical result is higher than normal for a particular location. The desired evaluation frequency is semi-monthly, within one week of the 15th and last day of any given month.

Screening for reasonable cause to suspect a new source:

IF — The mean concentration of any of the screening indicator variables in Table 10-1 exceeds the 95% UTL of baseline for that variable,[45]

THEN — The Site will evaluate the need for further action under RFCA ALF, such as source evaluation and control. Evaluations will address persistence, trends, and risk of Action Level exceedances at POEs.

Table 10-6. New Source Detection Monitoring Analytical Data Evaluation.

Location Code	Evaluation Type[a]
SW093	95% UTLs; Loading Analysis
SW091	95% UTLs
GS10	95% UTLs; Loading Analysis
SW022	95% UTLs
SW027	95% UTLs; Loading Analysis

Notes: [a] Details on the evaluation of analytical results are given in the Appendices.

The following sections present the NSD monitoring data evaluations on a location-specific basis. Each section includes a table of summary statistics for the location-specific analytes of interest, 95% UTL plots, box plots, and plots of the temporal variation of suspended solids Pu and Am activity.

The following evaluations include all results that were not rejected through the verification and validation process. Data are generally presented to decimal places as reported by the laboratories. Accuracy should not be inferred; minimum detectable concentrations/activities and analytical error are often greater than the precision presented. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the 'real' and the 'duplicate' values. When a sample has multiple 'real' analyses (e.g., Site requested 'reruns'), the value used in calculations is the arithmetic average of the multiple 'real' analyses. Total uranium is calculated by summing the activities for the analyzed isotopes (U-233,234 + U-235 + U-238).

For the summary tables, when a negative radionuclide result (e.g., -0.002 pCi/L) is reported by the laboratory due to blank correction, then a value of 0.0 pCi/L is used for calculation purposes. When TSS results are reported by the laboratory as 'undetect', one-half of the detection limit is used for calculation purposes.

The method for calculating UTLs is given in Appendix B.1: Data Evaluation Methods. For this report, the three year period of WY03–05 was used to calculate the UTL values. UTL lines are shown on the plots only for the determined normal or lognormal distribution. When the data satisfy either a normal or lognormal distribution, both UTL lines are plotted; when no distribution is determined, no line is plotted. A common legend is used in all UTL plots.

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[45] Closure activities are expected to result in modifications to contaminant source areas, drainage pathways, and runoff distribution. Such changes in water quality would not necessarily be indicative of a release. Consequently, tolerance limits are being used here to help identify acute releases of contaminants as opposed to long-term changes in water quality. The shortcoming of this approach is that chronic releases may not be indicated by comparison with tolerance limits; however, significant chronic trends should be measured through the POE and POC monitoring objectives. Evaluation will address persistence, trends, and risk of Action Level and/or Standard exceedances at POEs and POCs. On a random basis, 5% of the data is expected to exceed the UTL.

Box plots were calculated using S-Plus® statistical evaluation software. For these plots, when a negative radionuclide result (e.g., -0.002 pCi/L) is reported by the laboratory due to blank correction, then a value of 0.0 pCi/L is used for calculation purposes. A key describing the components of the box plots is given in Appendix B.1: Data Evaluation Methods.

The temporal variation of suspended solids activity plots are included as an indication of changes in the contamination characteristics of a particular drainage basin. A suspended solids activity that decreases over time may indicate that contaminant sources have been removed from the drainage, clean solids have become more available to runoff, or contaminant sources have been naturally attenuated over time. Similarly, a suspended solids activity that increases over time may indicate that new contaminant sources have become available for transport and/or that an existing source has become more available for transport in the drainage. TSS analysis is only performed for composite samples that are collected over a period of less than the TSS hold time (7 days). Consequently, not all samples collected at the locations below were analyzed for TSS. Only values greater than the detection limit (generally 5 mg/L for TSS, 0.015 pCi/L for Pu and Am) are included.

Plots of mean daily water temperature, pH, specific conductivity, and turbidity are also included.[46] The methods used for the water-quality parameter evaluations are given in Appendix B.5: Real-Time Water-Quality Parameters. The loading analysis for GS10, SW027, and SW093 is presented in Section 5.

10.3.1 Location GS10

Monitoring location GS10 is located on South Walnut Creek at the perimeter of the IA just upstream of the B-Series Ponds. Figure 3-31 shows the drainage area for GS10. The 100, 300, 400, 500, 600, 700, 800, and 900 areas all contribute flow to GS10.

Figure 10-2 and Figure 10-3 show the UTL plots for Pu and Am, respectively. During WY03–05, a single Am result was greater than the calculated UTL, with significant variability in the results. The higher WY05 Pu and Am activities resulted in reportable 30-day averages under the POE monitoring objective (Section 11). In response, the Site was required to continue the ongoing source evaluations to address these reportable values. A summary of the extensive investigations is given in Section 6.3. It should be noted that Pu shows a measurable increase in WY04 due to increased transport of disturbed soils associated with Closure activities. Source evaluation for POE GS10 identified runoff from the 903 Pad area as the primary contributor of Pu and Am load in WY04. In WY05, both Pu and Am show a temporary increase. The source evaluation for POE GS10 identified solids transport resulting from the construction of Functional Channel #4 and Closure actions in the 700 Area as the primary contributor of Pu and Am load at GS10 in WY05. With the completion of the functional channels, implementation of enhanced erosion controls, revegetation, and soil stabilization, transport of Pu and Am approaching the action level has been virtually eliminated.

Table 10-7 shows moderate total uranium activities with recent higher results at GS10. Figure 10-4 shows the UTL plot for total uranium. During WY03–05, recent uranium results are greater than the calculated UTLs, with a noticeable upward trend. These values resulted in reportable 30-day averages under the POE monitoring objective (Section 11). Source evaluation at GS10 identified hydrologic changes at GS10 as the cause of the increases in total uranium. As impervious areas were removed at the Site (reducing direct runoff during precipitation events), groundwater contributions to the creek with naturally occurring uranium represented a larger portion of the streamflow monitored at GS10. Without direct runoff contributions to mix with the groundwater uranium contributions, samples from GS10 began to reflect the naturally occurring groundwater uranium concentrations (often significantly greater than the surface-water action level).

Since 1999, RFETS groundwater and surface water samples from select locations have been sent to Los Alamos National Laboratory for high resolution inductively coupled mass spectrometry (HR ICP/MS) and/or thermal ionization mass spectrometry (TIMS) analyses. These analyses measure mass ratios of the four uranium isotopes

[46] Mean daily water-quality values are given for days of measurable flow. Some data may be missing due to equipment failures and removal for calibration.

(masses 234, 235, 236, and 238) and are detailed in the reports titled "Uranium in Surface Soil, Surface Water, and Groundwater at the Rocky Flats Environmental Technology Site, dated June 2004" and in the "Interim Measure/Interim Remedial Action for Groundwater at the Rocky Flats Environmental Technology Site, dated June 21, 2005".. Isotopic ratios provide a signature that indicates whether the source of uranium is natural or anthropogenic (man-made). The results to date indicate that all the groundwater and surface-water locations at the Site display a predominately natural signature.

GS10 generally shows a downward long-term trend (based on linear regression) in suspended solids activity (Figure 10-6) for both Pu and Am.

Table 10-7. Summary Statistics for Radionuclide Results from GS10: WY03-05.

Analyte	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]	95% UTL [pCi/L]
Pu-239,240	83	0.065	0.457	1.320	1.62[a]
Am-241	79	0.061	0.226	1.530	0.724[c]
Total Uranium	83	3.911	7.371	13.96	11.4[a]

Note: Total uranium is calculated as the sum of the isotopic (U-233,234; U-235; U-238) activities.
[a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.

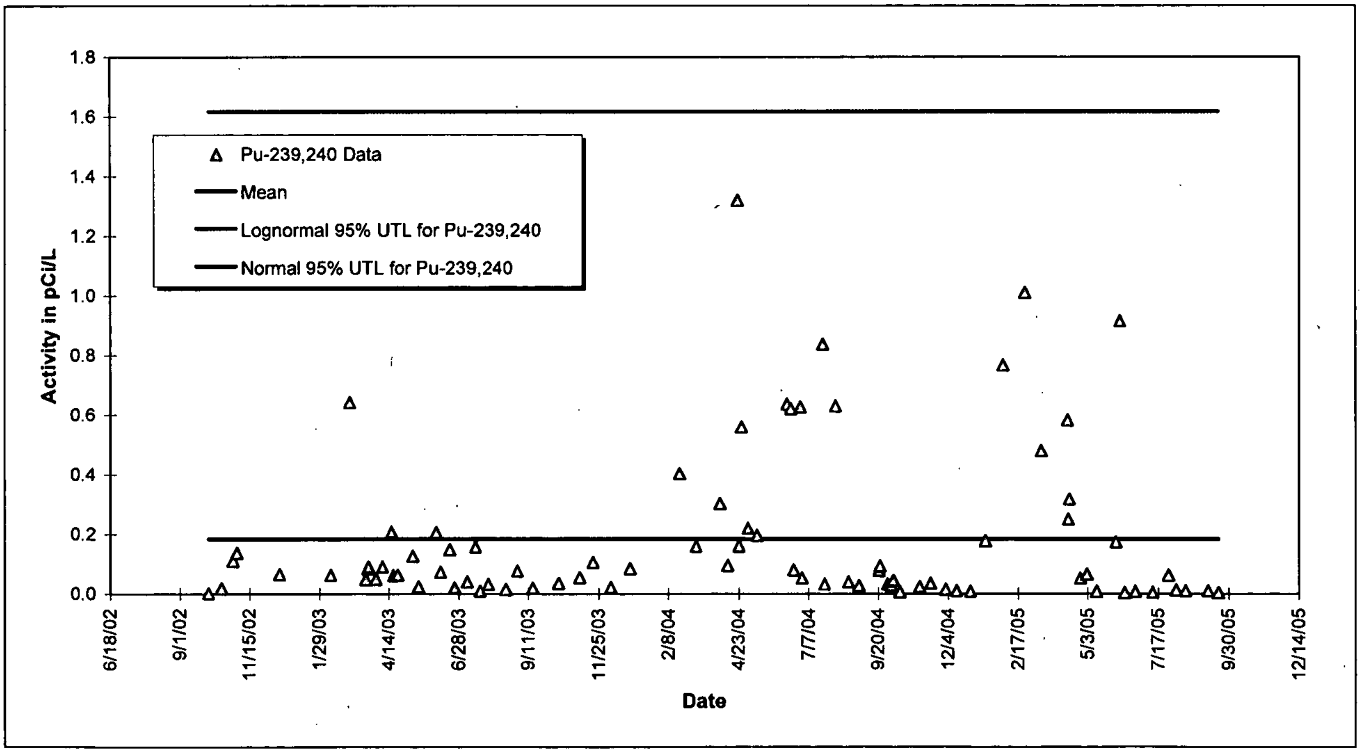


Figure 10-2. 95% UTL Plot for Pu-239,240 at GS10: WY03-05.

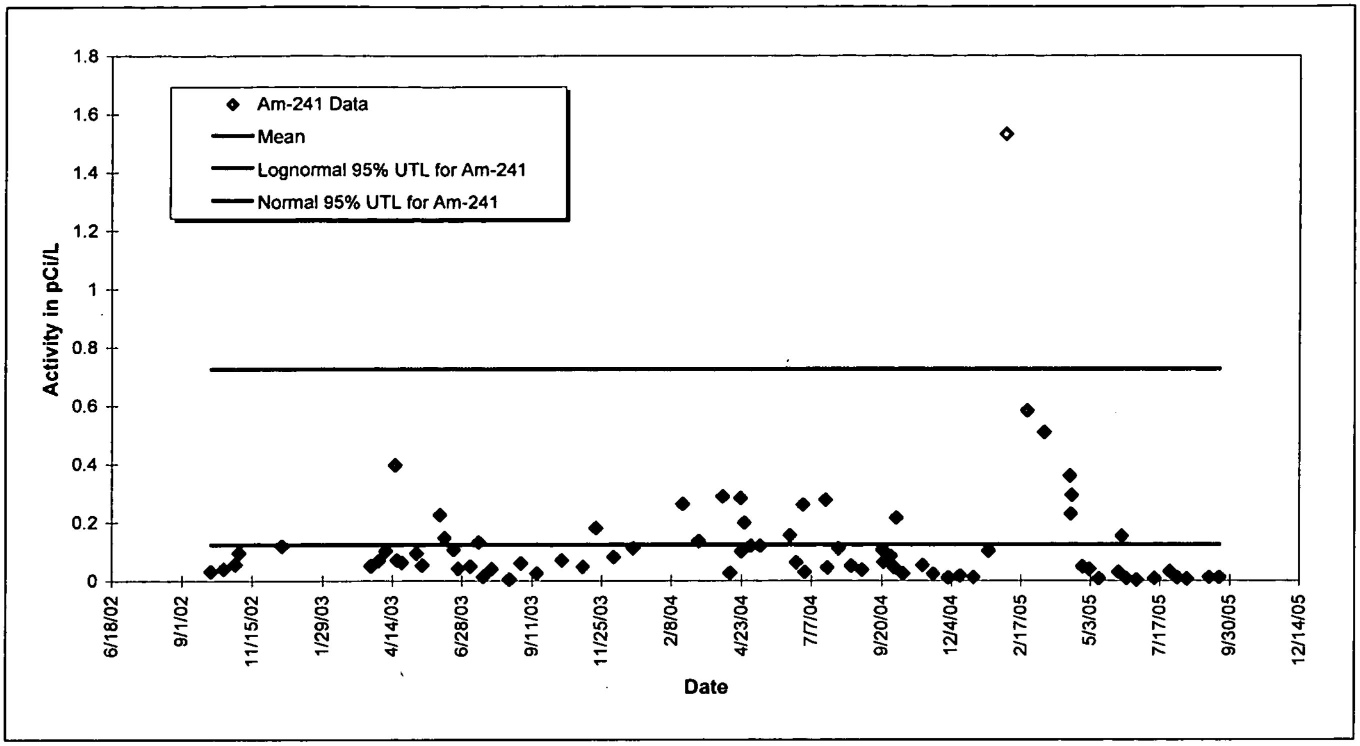


Figure 10-3. 95% UTL Plot for Am-241 at GS10: WY03-05.

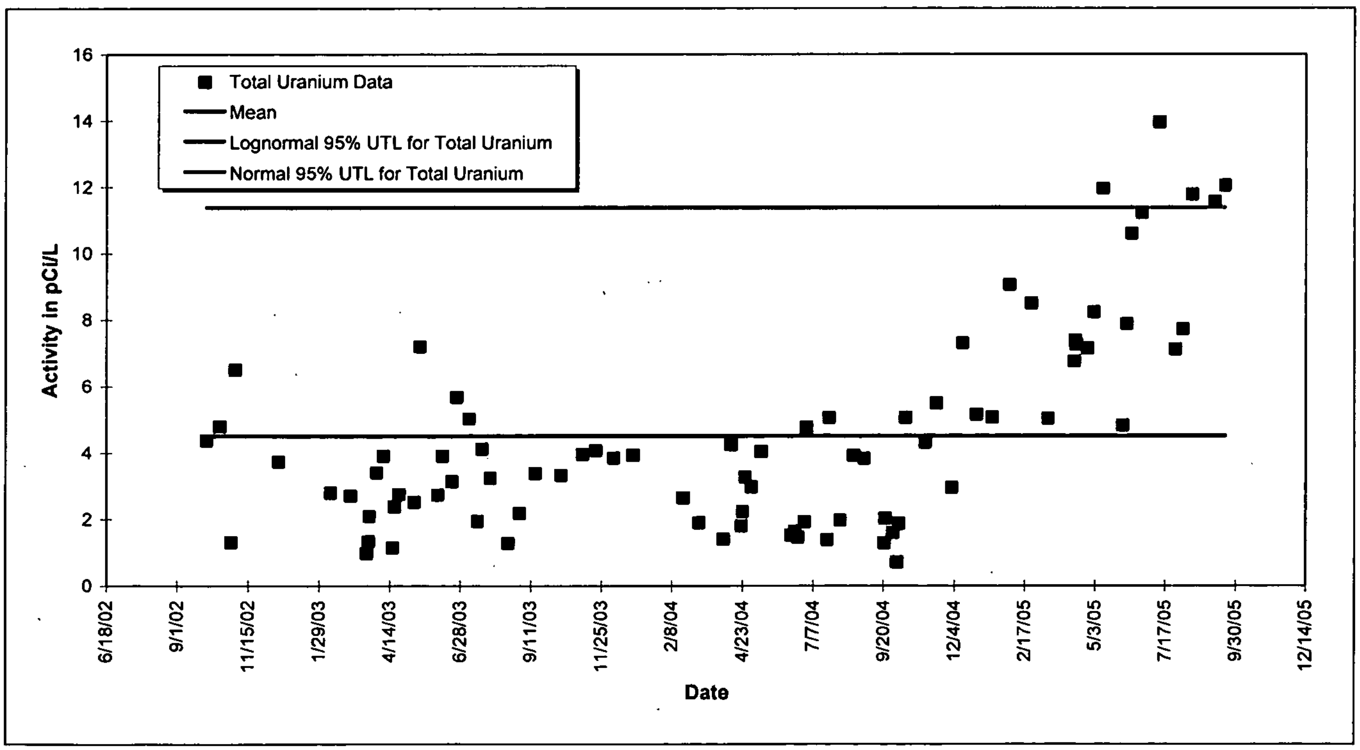


Figure 10-4. 95% UTL Plot for Total Uranium at GS10: WY03-05.

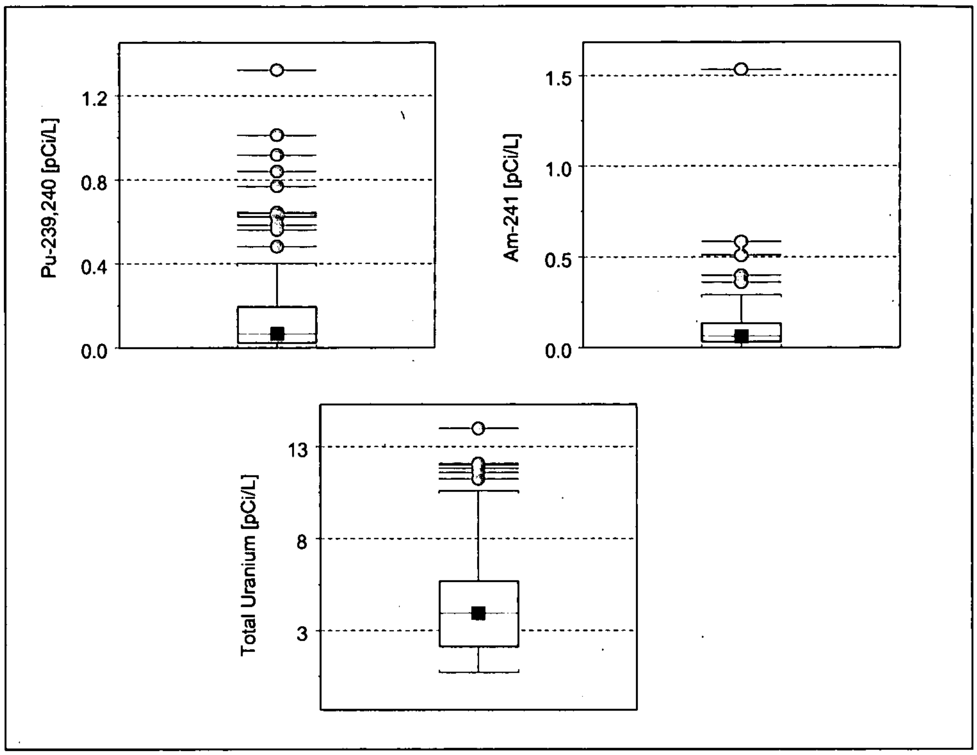


Figure 10-5. Radionuclide Box Plots for GS10: WY03–05.

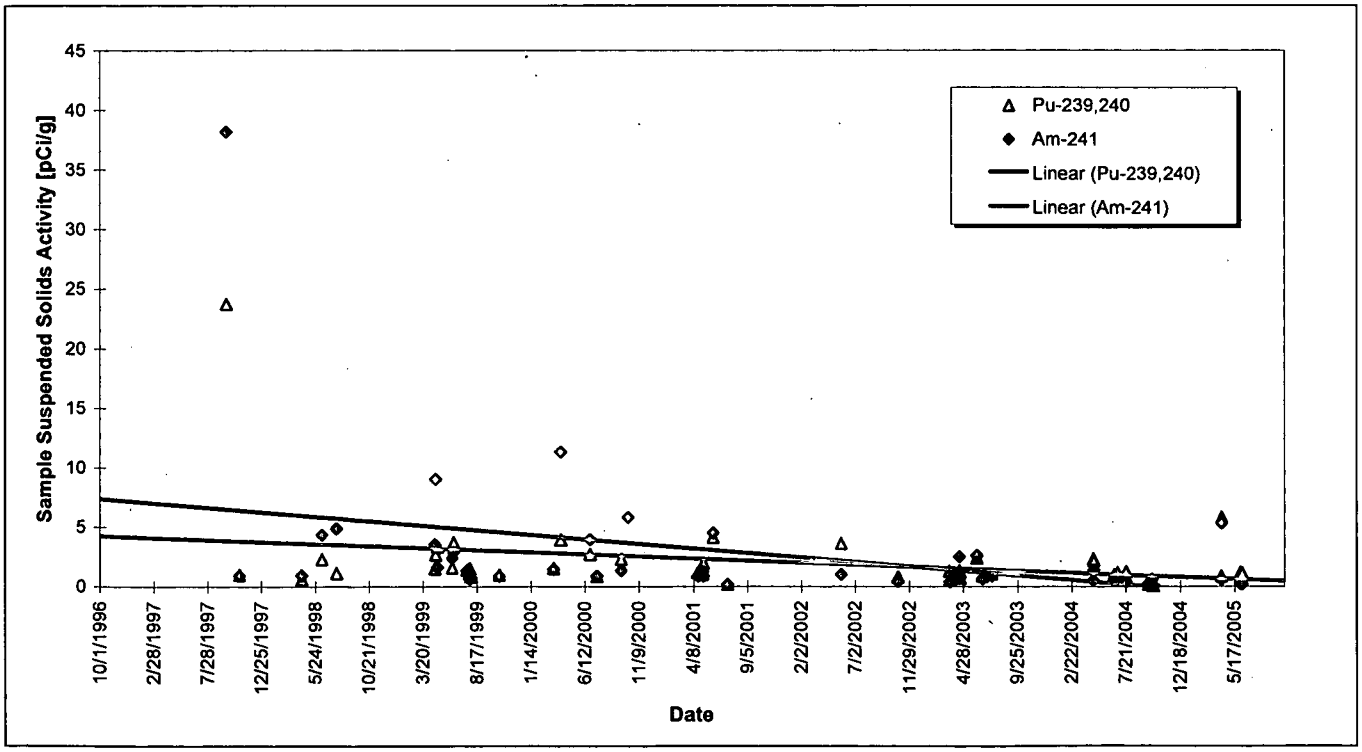


Figure 10-6. Temporal Variation of Suspended Solids Activity at GS10: WY97–05.

Mean daily water-quality parameter data are plotted in Figure 10-7 through Figure 10-14 along with the mean daily flow rate. Figure 10-7 and Figure 10-8 show the expected annual variation in water temperature.

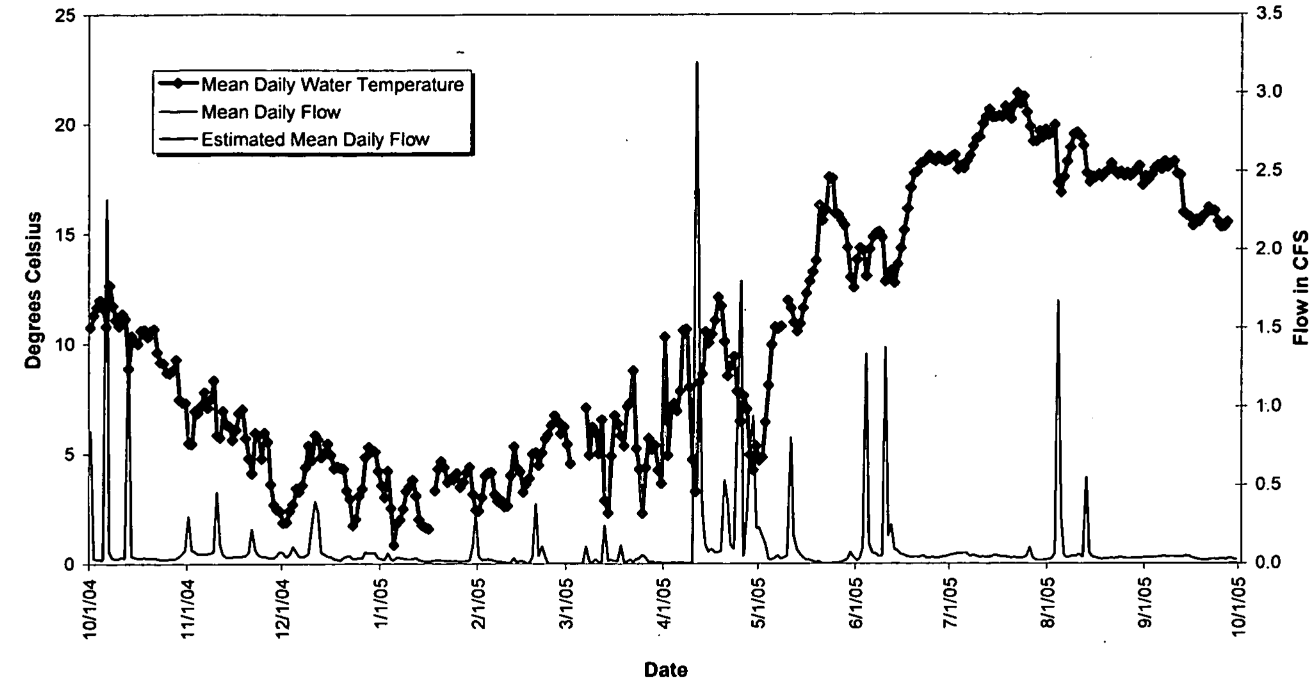


Figure 10-7. Mean Daily Water Temperature at GS10: WY05.

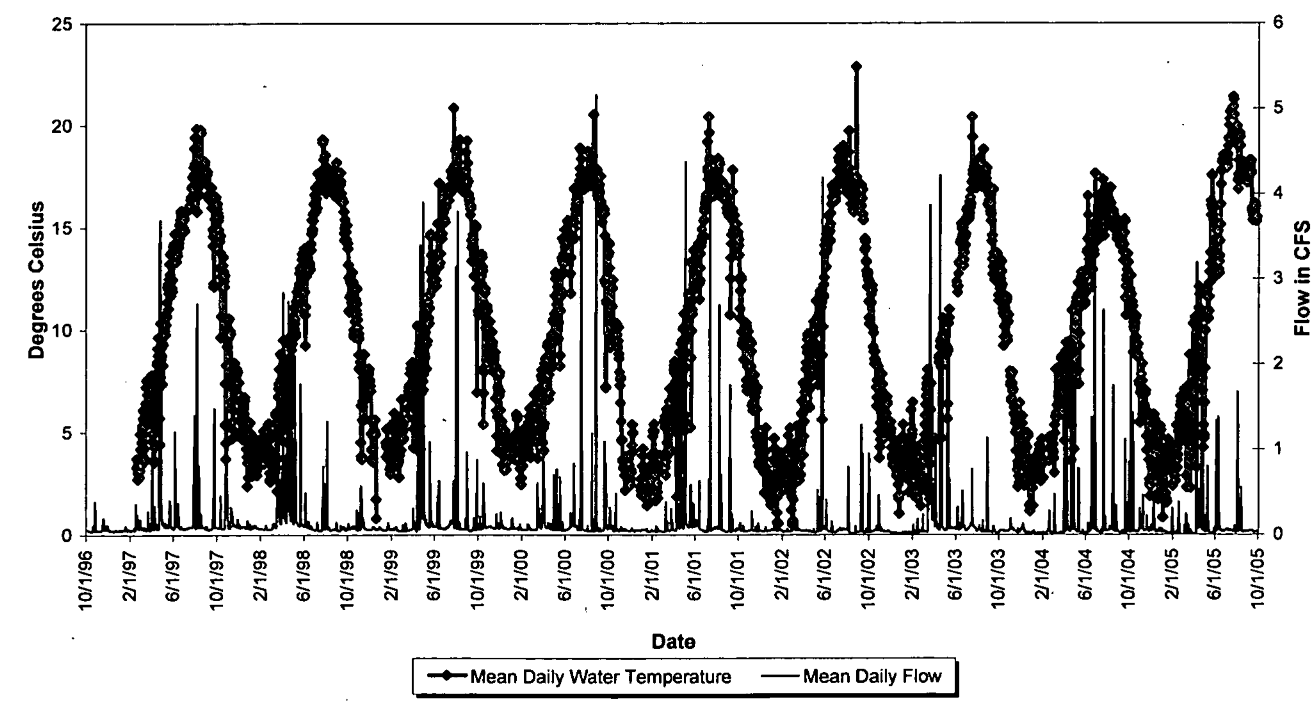


Figure 10-8. Mean Daily Water Temperature at GS10: WY97-05.

Figure 10-9 and Figure 10-10 show elevated conductivities during the winter months, most likely a result of road and walkway deicing operations. The effects of changes in deicing products (magnesium chloride) starting in WY00 can be clearly seen in Figure 10-10 as increased conductivity.

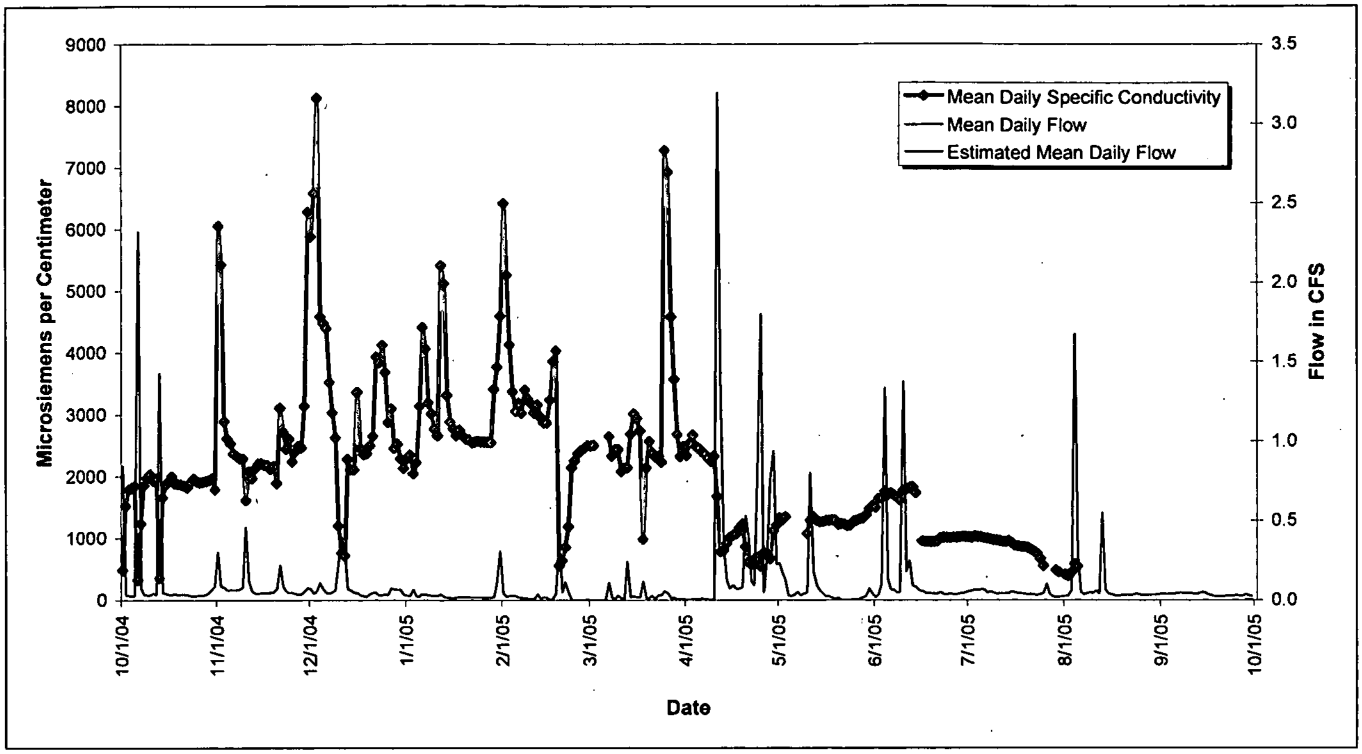


Figure 10-9. Mean Daily Specific Conductivity at GS10: WY05.

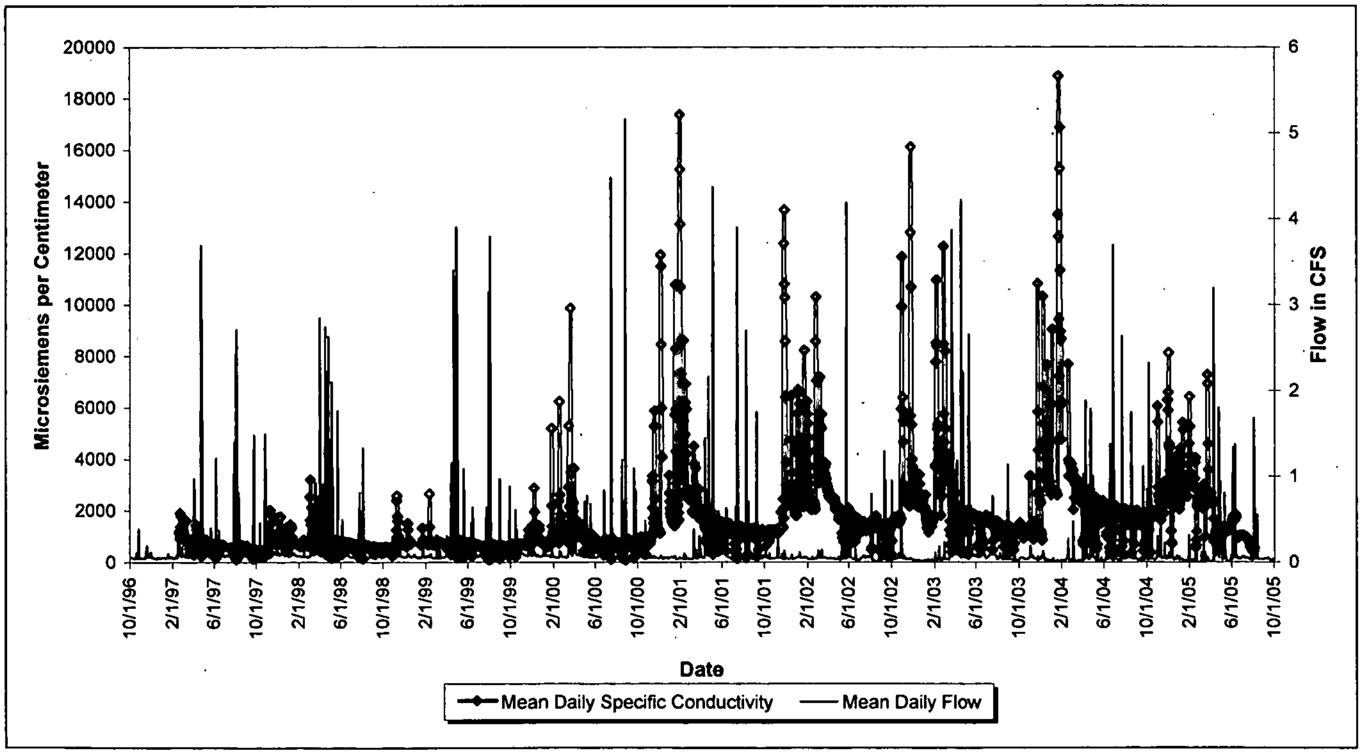


Figure 10-10. Mean Daily Specific Conductivity at GS10: WY97-05.

Figure 10-11 and Figure 10-12 show the mean daily pH varying between 6.5 and 9.1.

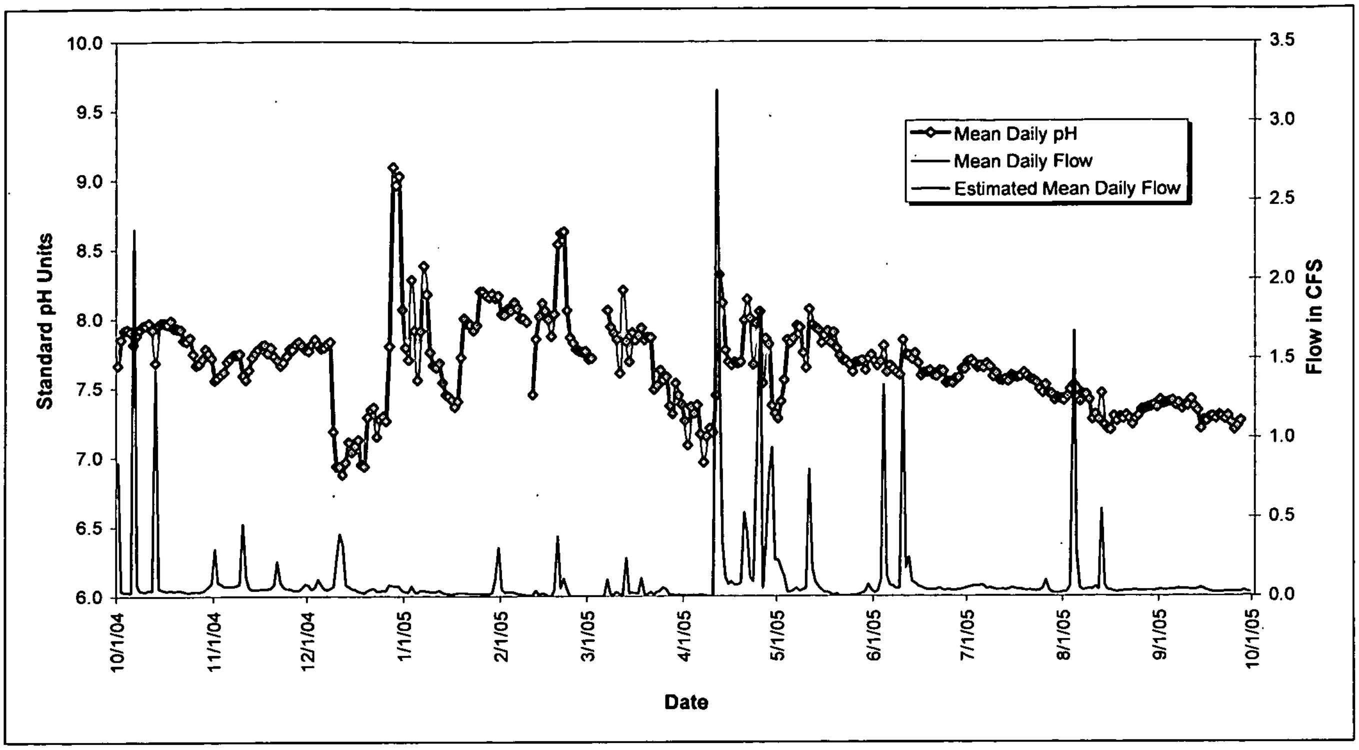


Figure 10-11. Mean Daily pH at GS10: WY05.

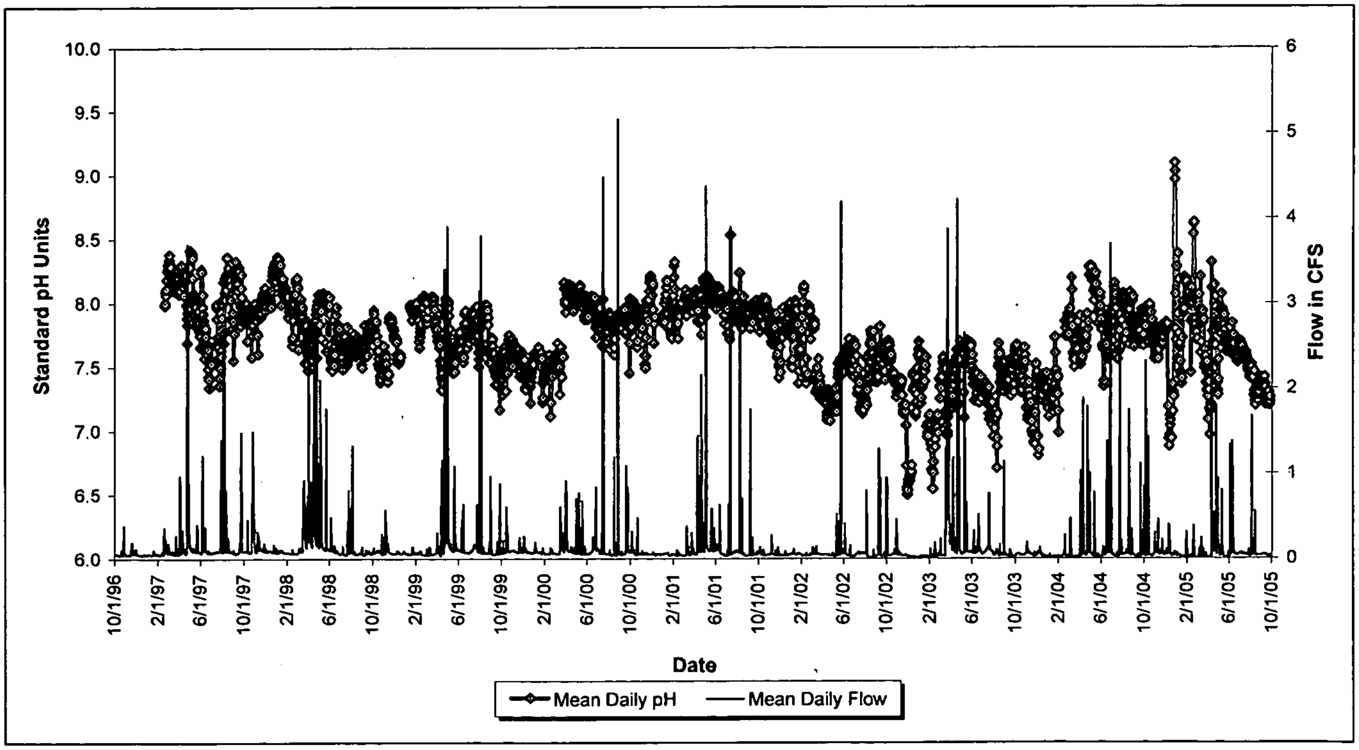


Figure 10-12. Mean Daily pH at GS10: WY97-05.

Finally, Figure 10-13 and Figure 10-14 show elevated turbidity measurements tracking the flow rate in time and magnitude, as expected when higher flow rates transport more suspended solids. WY04-05 shows measurably higher turbidities due to increased transport of solids from disturbed soils associated with Closure activities. The majority of the turbidity data after completion of the functional channels show low levels.

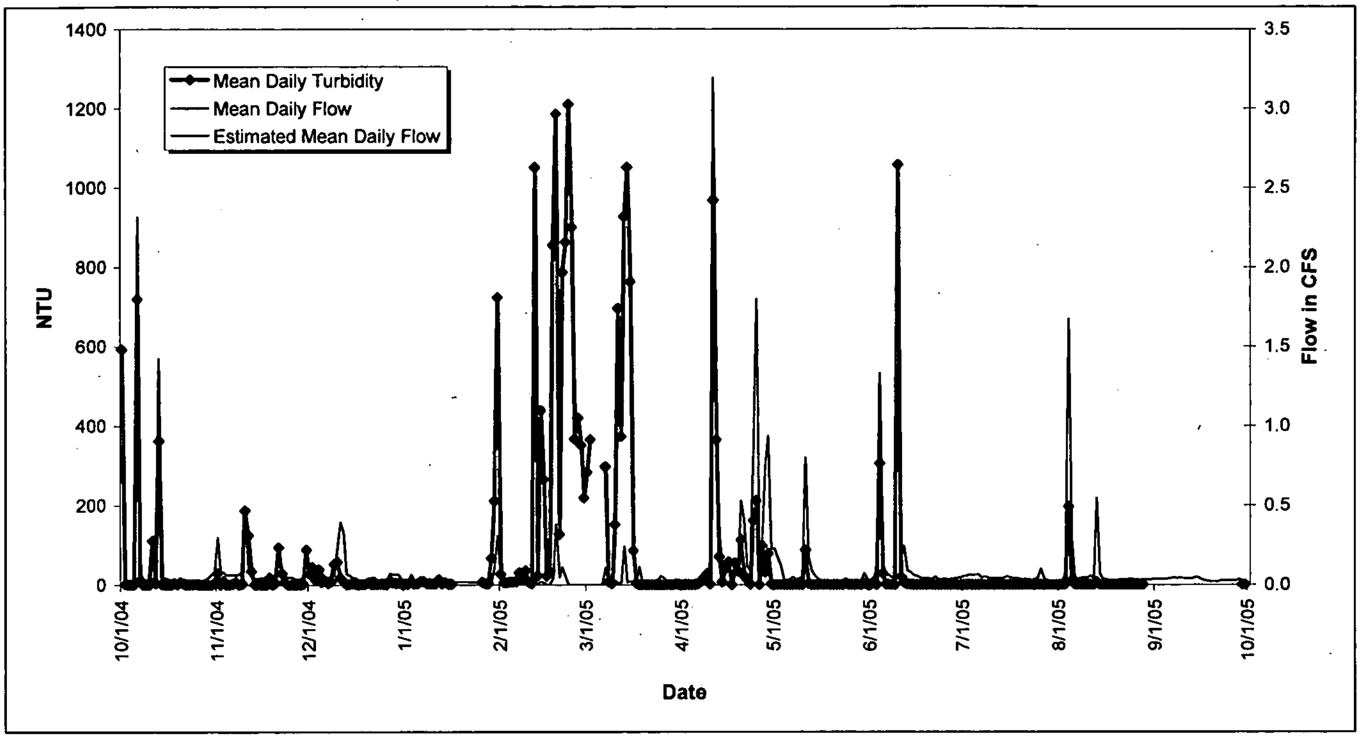


Figure 10-13. Mean Daily Turbidity at GS10: WY05.

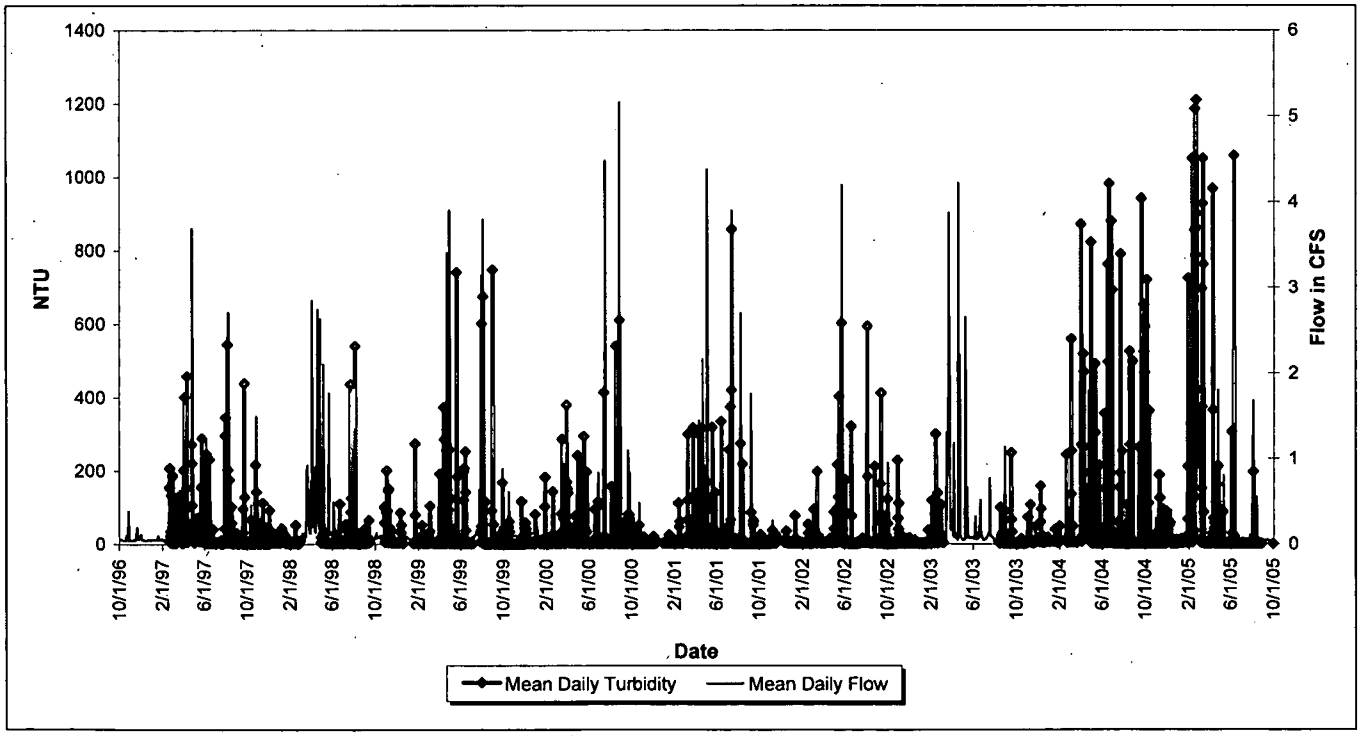


Figure 10-14. Mean Daily Turbidity at GS10: WY97-05.

10.3.2 Location SW022

Monitoring location SW022 is located at the end of Central Avenue Ditch just upstream of the diversion structure that routes flows to South Walnut Creek and GS10. Figure 3-113 shows the drainage area for SW022. The 100, 400, 600, 800, and 900 areas all contribute flow to SW022. Operation of SW022 was discontinued on 4/17/05.

Monitoring data collected at SW022 show moderate median Pu and Am activities (Table 10-8), although several higher results have been measured (Figure 10-18). Figure 10-15 and Figure 10-16 show the Pu and Am UTL plots, respectively. During WY03–05, no Pu or Am results exceeded the calculated UTL. It should be noted that Pu and Am both show measurable increases in WY04 due to increased transport of disturbed soils associated with Closure activities. Source evaluation for POE GS10 identified runoff from the 903 Pad area as the primary contributor of Pu and Am load in WY04. Runoff from the 903 Pad area flows to SW022 before reaching GS10. With the implementation of enhanced erosion controls, revegetation, and soil stabilization, transport of Pu and Am was significantly reduced in WY05.

Monitoring data collected at SW022 show low median total uranium activities (Table 10-8). A distribution for total uranium could not be determined because of significant variability in the results. A single high result was observed; all other results are low and no trend is noted.

The temporal variation of suspended solids activity (Figure 10-19) shows a visual long-term trend downward based on linear regression.

Table 10-8. Summary Statistics for Radionuclide Results from SW022 in WY03-05.

Analyte	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]	95% UTL [pCi/L]
Pu-239,240	29	0.167	0.870	2.340	4.42[a]
Am-241	29	0.063	0.171	0.308	0.507[a]
Total Uranium	29	1.19	2.11	23.4	NA[c]

Note: Total uranium is calculated as the sum of the isotopic (U-233,234; U-235; U-238) activities.
[a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.

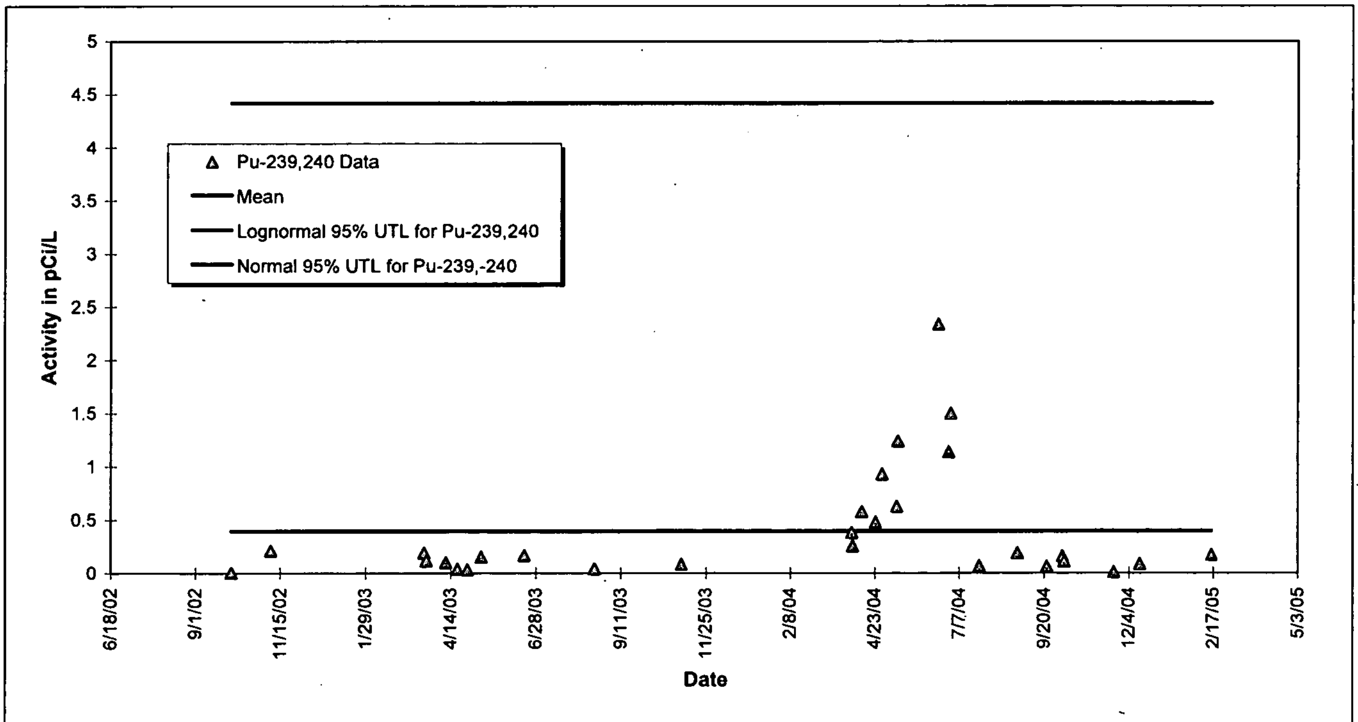


Figure 10-15. 95% UTL Plot for Pu-239,240 at SW022: WY03-05.

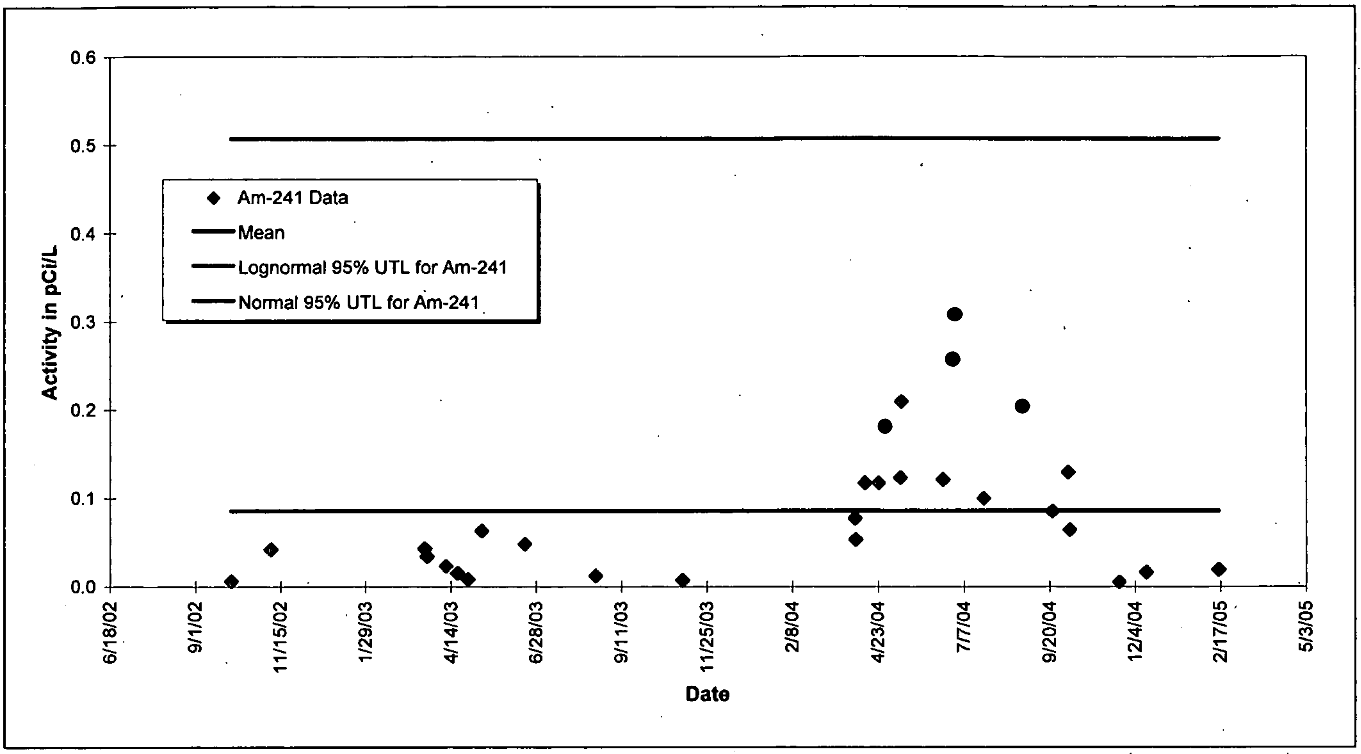


Figure 10-16. 95% UTL Plot for Am-241 at SW022: WY03-05.

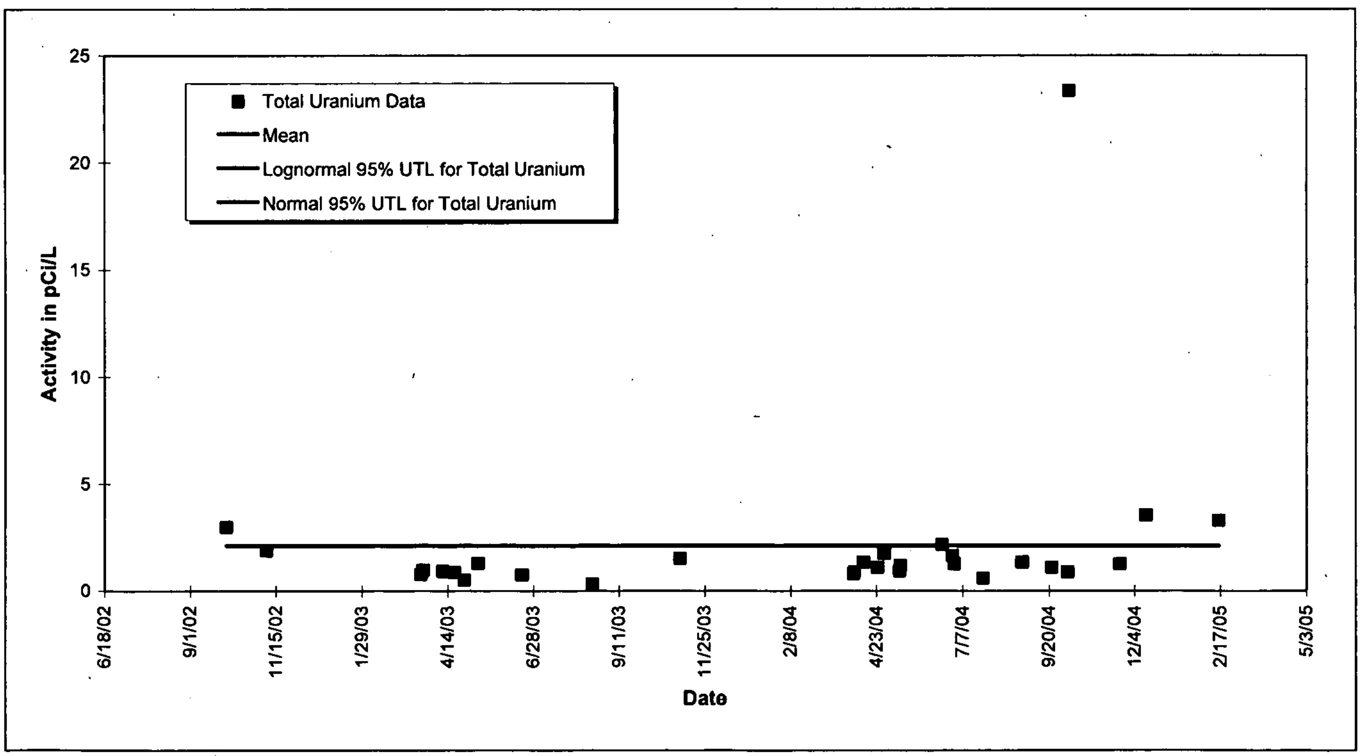


Figure 10-17. 95% UTL Plot for Total Uranium at SW022: WY03-05.

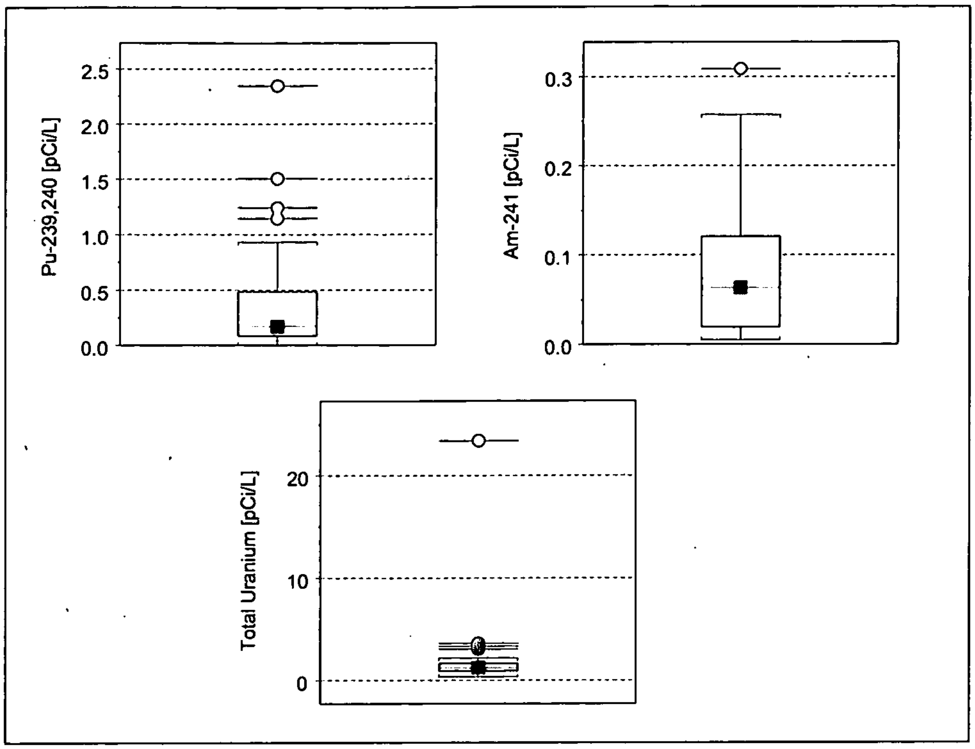


Figure 10-18. Radionuclide Box Plots for SW022: WY03–05.

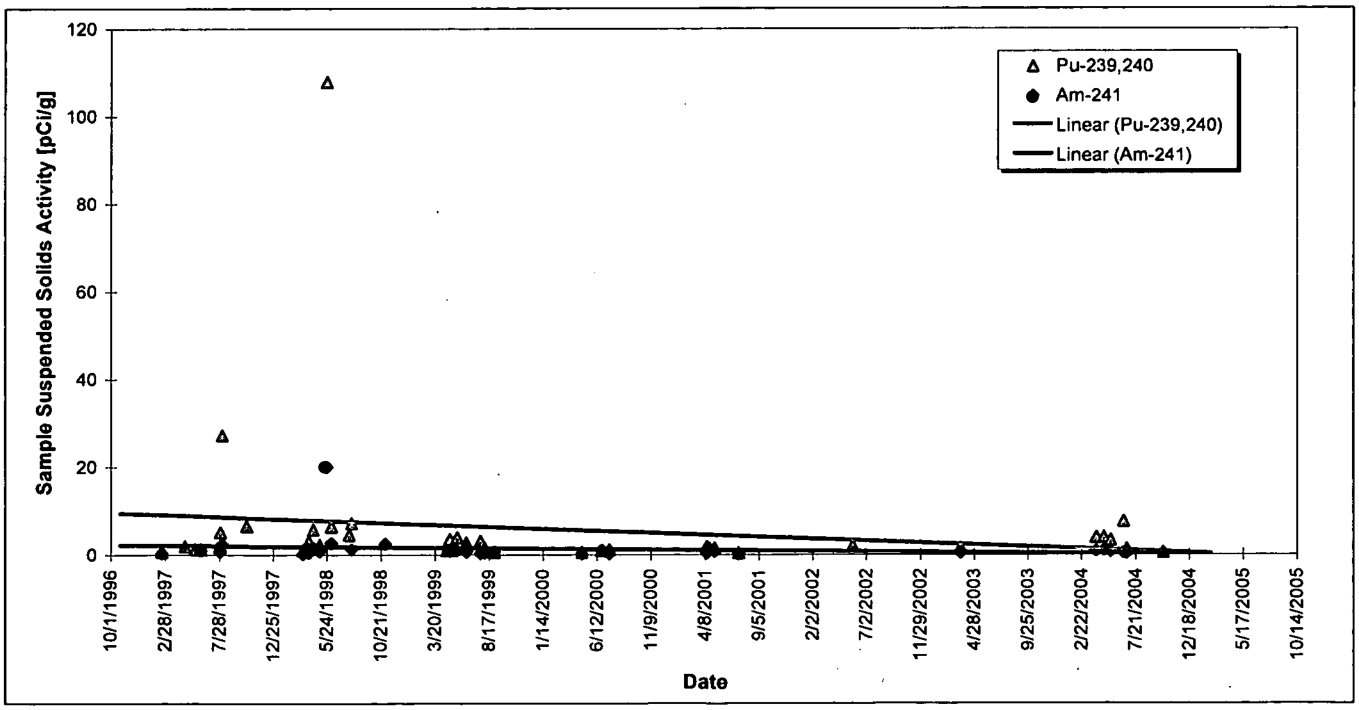


Figure 10-19. Temporal Variation of Suspended Solids Activity at SW022: WY97–05.

10.3.3 Location SW027

Monitoring location SW027 is located at the end of the SID at the inlet to Pond C-2. Figure 3-116 shows the drainage area for SW027. The 100, 400, 600, 800, and 900 areas all contribute flow to SW027.

Monitoring data collected at SW027 show the highest Pu activities measured for the NSD monitoring locations (Table 10-9).[47] Monitoring data collected at SW027 show moderate median Pu and Am activities, though some significantly higher results have been obtained (Figure 10-23). Figure 10-20 and Figure 10-21 show the UTL plots for Pu and Am, respectively. During WY03–05, a statistical distribution could not be determined for either Pu or Am, because of significant variability in the results. The higher Pu and Am activities in WY04 resulted in reportable 30-day averages under the POE monitoring objective (Section 11). In response, the Site was required to perform source evaluations to address these reportable values. A summary of the extensive investigations is given in Section 6.3.4. The measurable Pu and Am increases in WY04 were due to increased transport of disturbed soils associated with Closure activities. Source evaluation for POE SW027 identified runoff from the 903 Pad/Lip area as the primary contributor of Pu and Am load in WY04. With the completion of the 903 Pad/Lip actions, implementation of enhanced erosion controls, revegetation, and soil stabilization, transport of Pu and Am approaching the action level has been virtually eliminated.

Table 10-9 shows low total uranium activities at SW027. During WY03-05, a single result was greater than the UTL (Figure 10-22), though the value was less than the action level and no subsequent data are available to assess this result.

SW027 shows a visually increasing trend based on linear regression in suspended solids activity, due to short-term increased transport from the 903 Pad/Lip (Figure 10-24) for the few TSS results obtained. WY05 data show a return to more 'normal' levels.

Table 10-9. Summary Statistics for Radionuclide Results from SW027: WY03-05.

Analyte	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]	95% UTL [pCi/L]
Pu-239,240	27	0.116	0.391	13.2	NA[c]
Am-241	27	0.019	0.128	2.33	NA[c]
Total Uranium	27	1.25	2.06	4.32	4.04[a]

Note: Total uranium is calculated as the sum of the isotopic (U-233,234; U-235; U-238) activities.
[a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.

[47] As of the publication of this report, the composite sample at SW027 started on 5/18/05 was still in progress. SW027 has not flowed since 6/14/05 and the composite currently contains 2.2 liters, a non-sufficient quantity for analysis. Therefore, the analytical results for this sample are not included in this section.

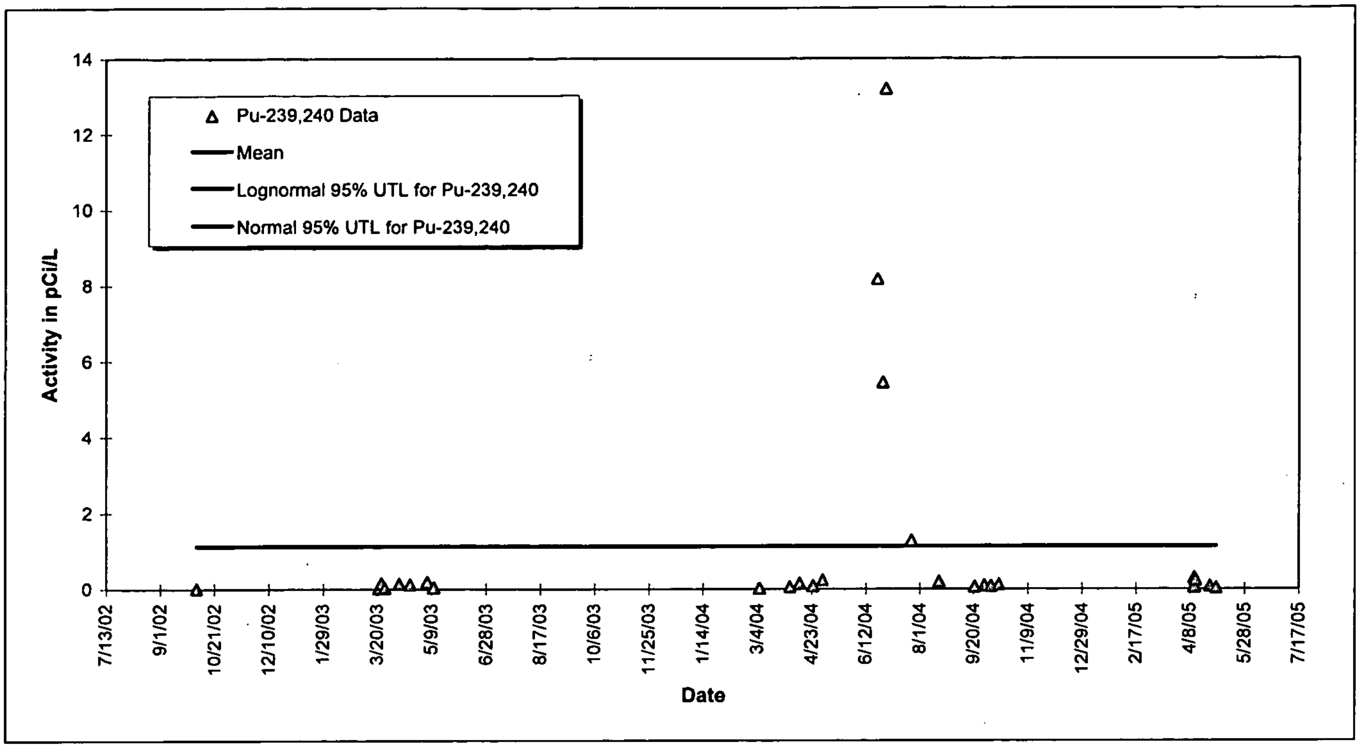


Figure 10-20. 95% UTL Plot for Pu-239,240 at SW027: WY03-05.

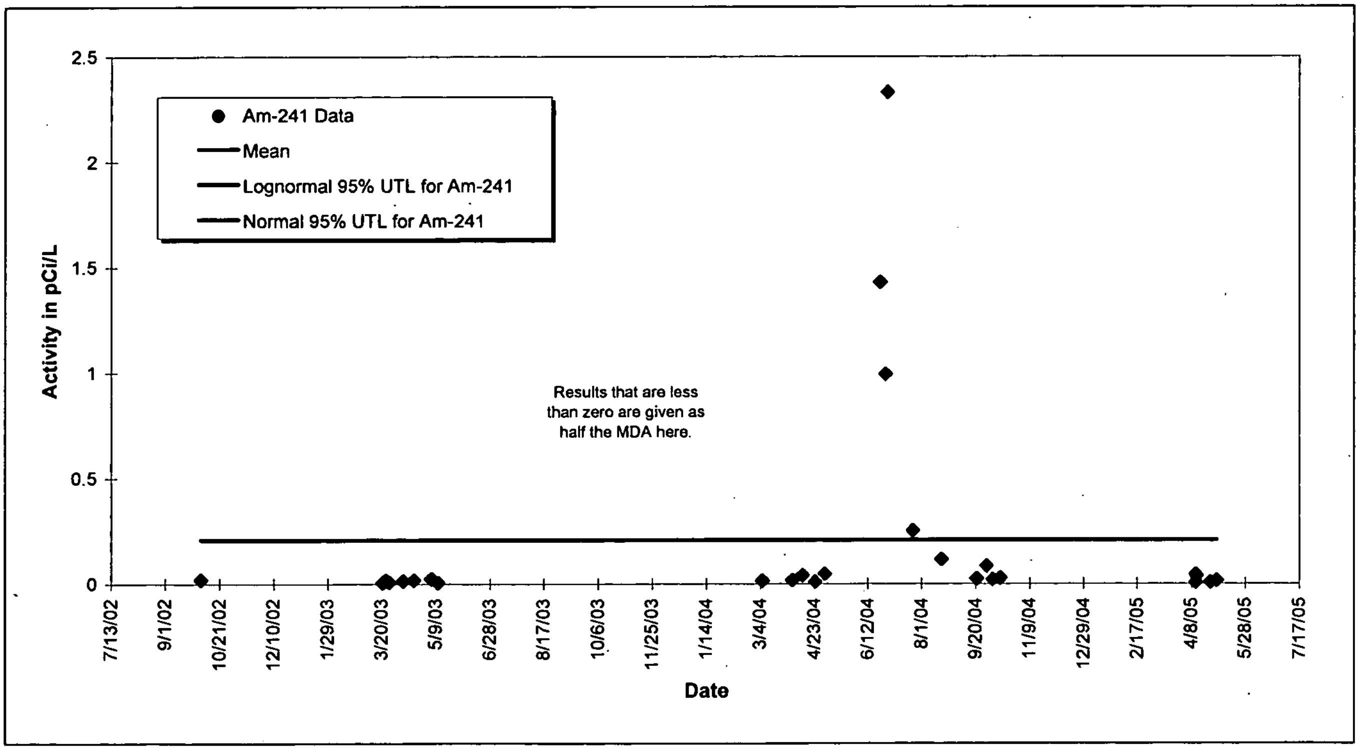


Figure 10-21. 95% UTL Plot for Am-241 at SW027: WY03-05.

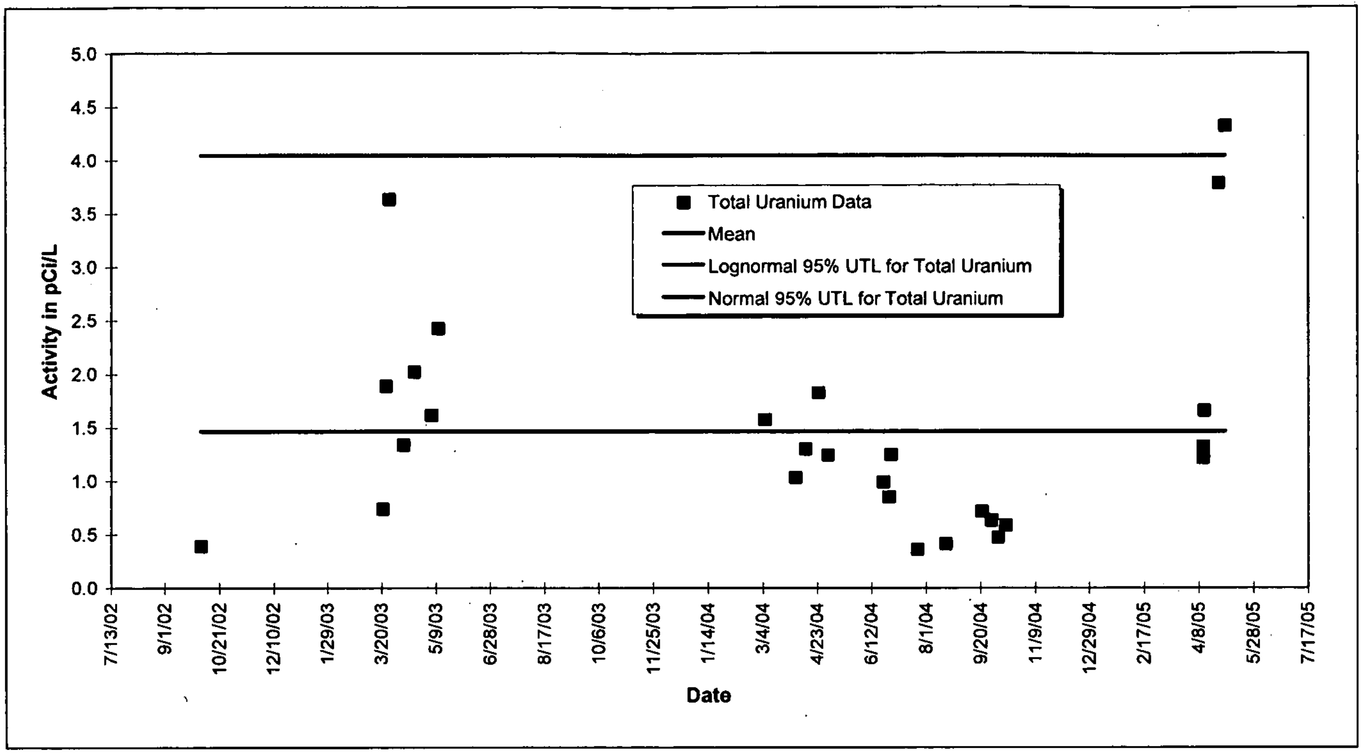


Figure 10-22. 95% UTL Plot for Total Uranium at SW027: WY03-05.

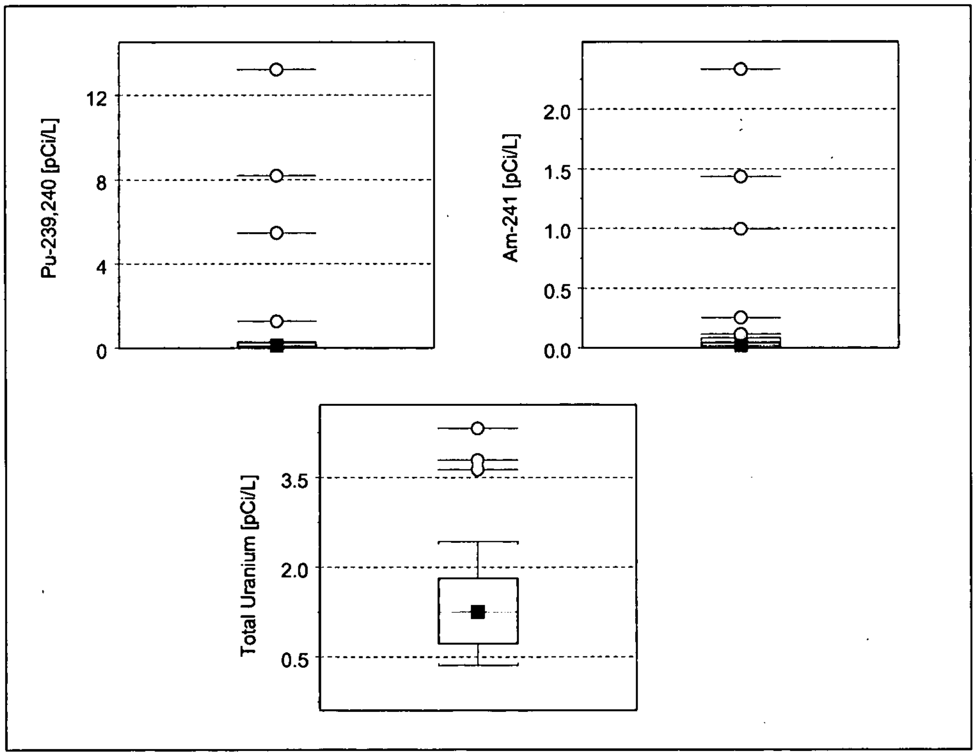


Figure 10-23. Radionuclide Box Plots for SW027: WY03–05.

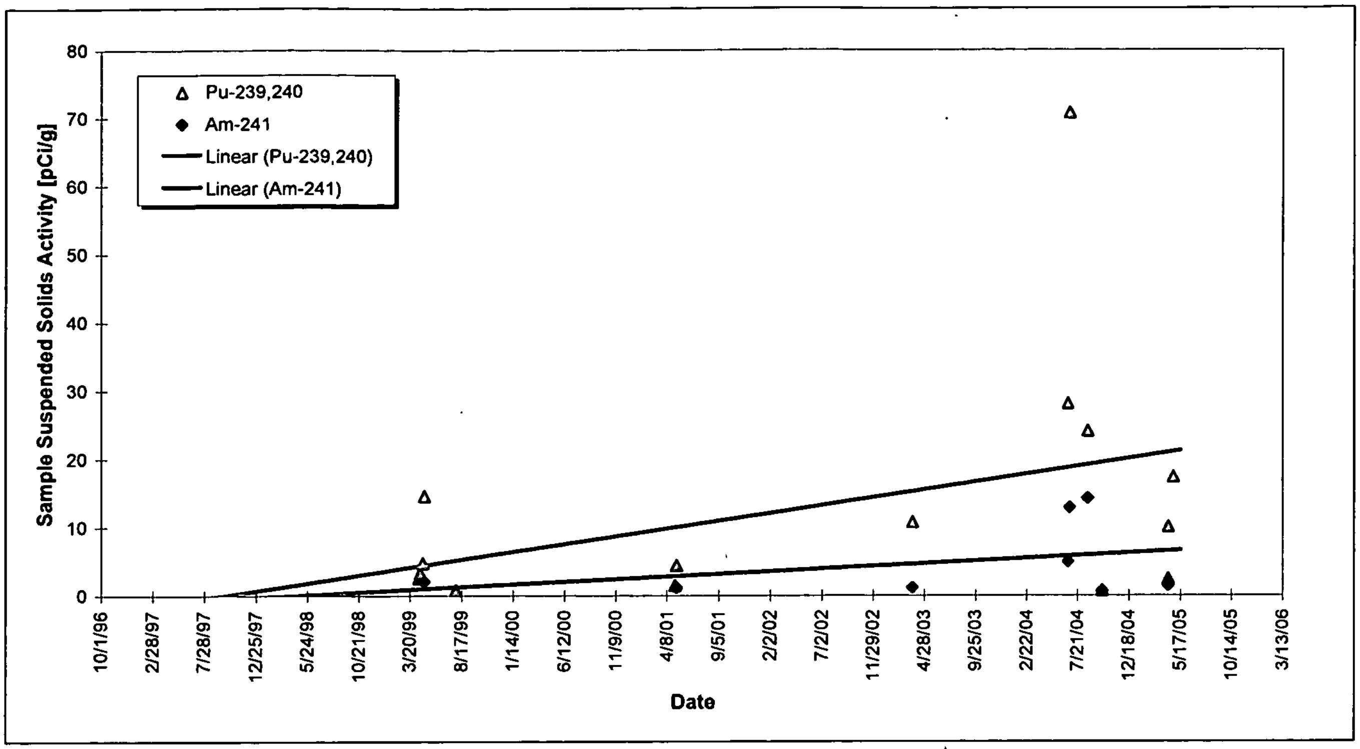


Figure 10-24. Temporal Variation of Suspended Solids Activity at SW027: WY97–05.

Mean daily water-quality parameter data are plotted in Figure 10-25 through Figure 10-32 along with the mean daily flow rate. Figure 10-25 and Figure 10-27 show the expected annual variation in water temperature.

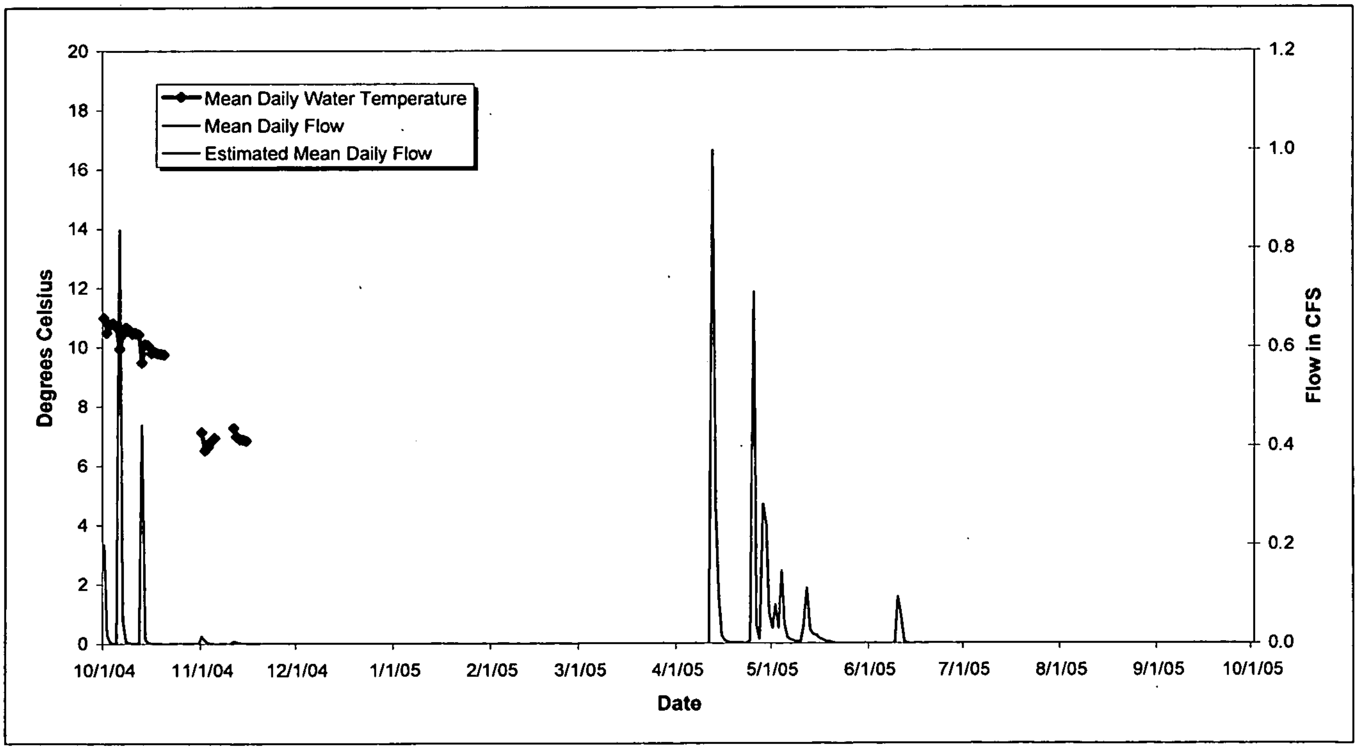


Figure 10-25. Mean Daily Water Temperature at SW027: WY05.

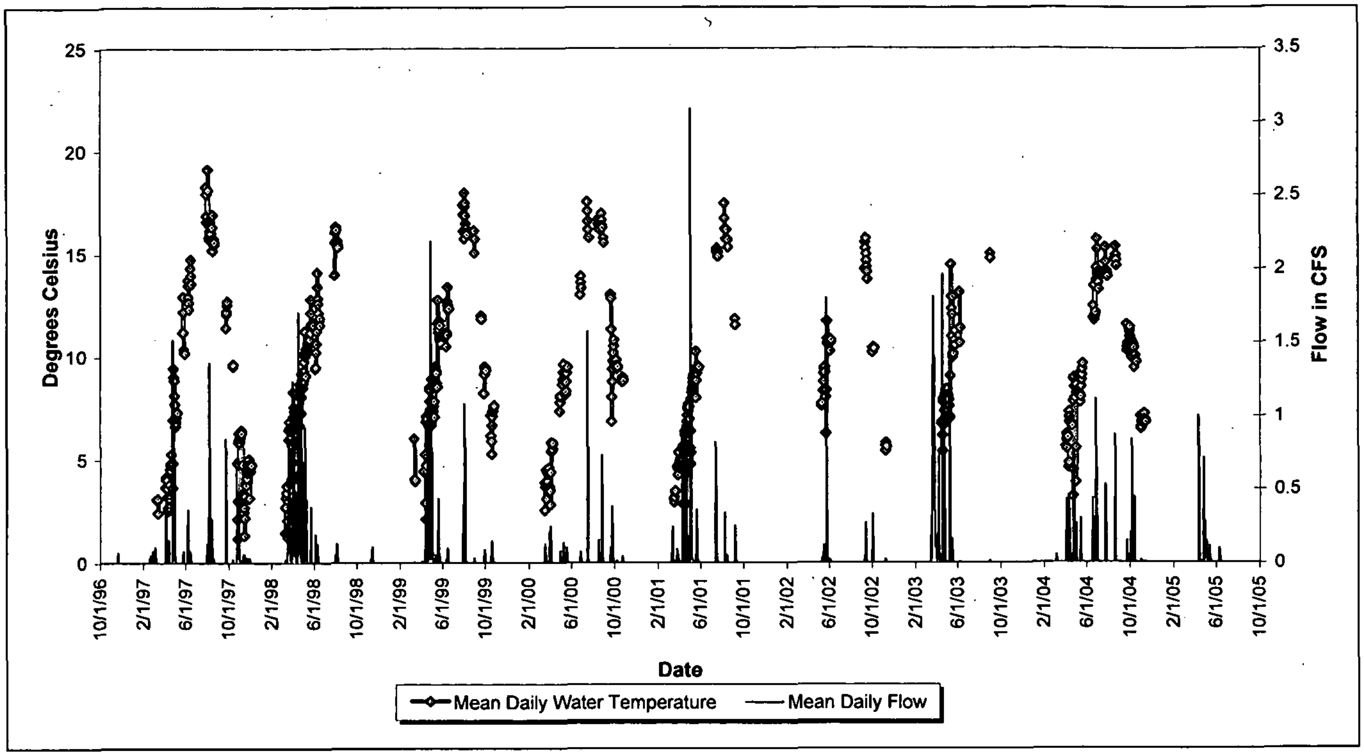


Figure 10-26. Mean Daily Water Temperature at SW027: WY97-05.

Figure 10-27 and Figure 10-28 show elevated conductivities during the first flow periods following winter months, most likely a result of road and walkway deicing operations.

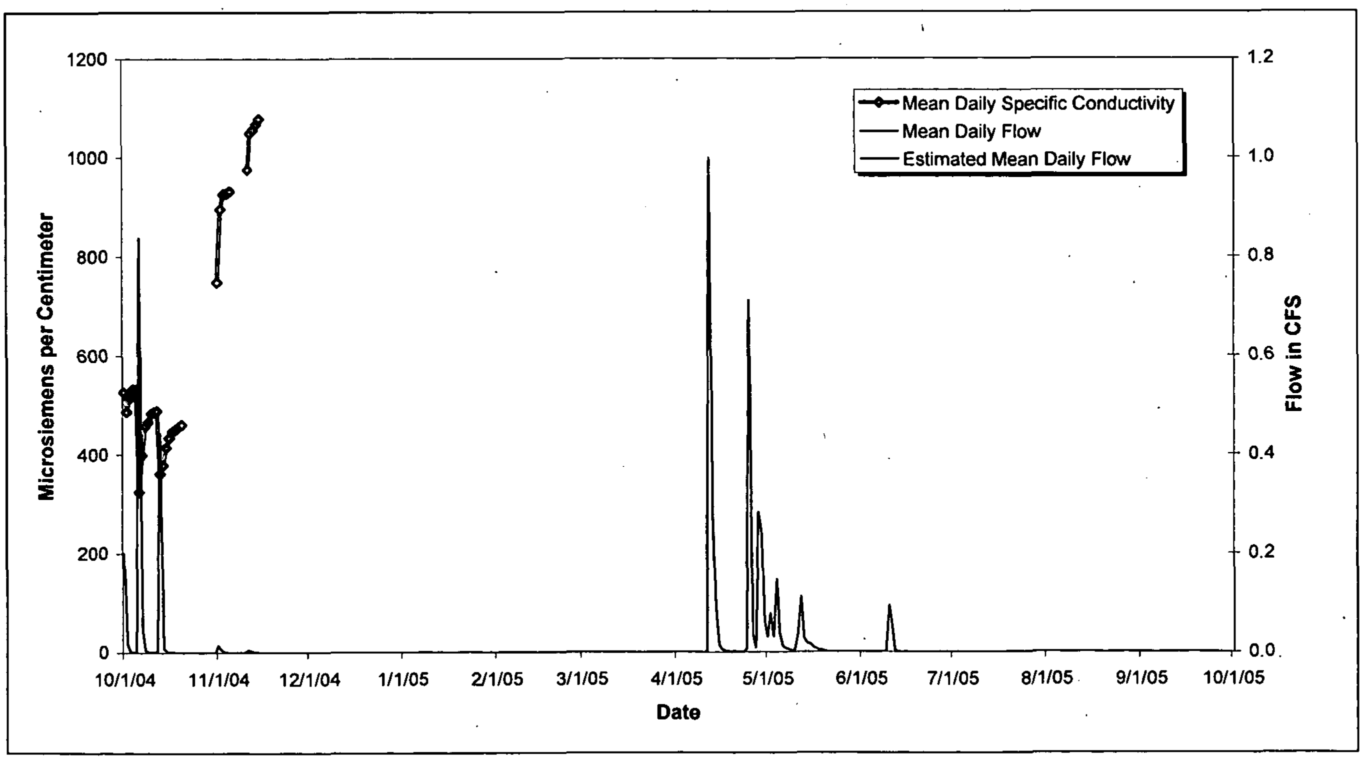


Figure 10-27. Mean Daily Specific Conductivity at SW027: WY05.

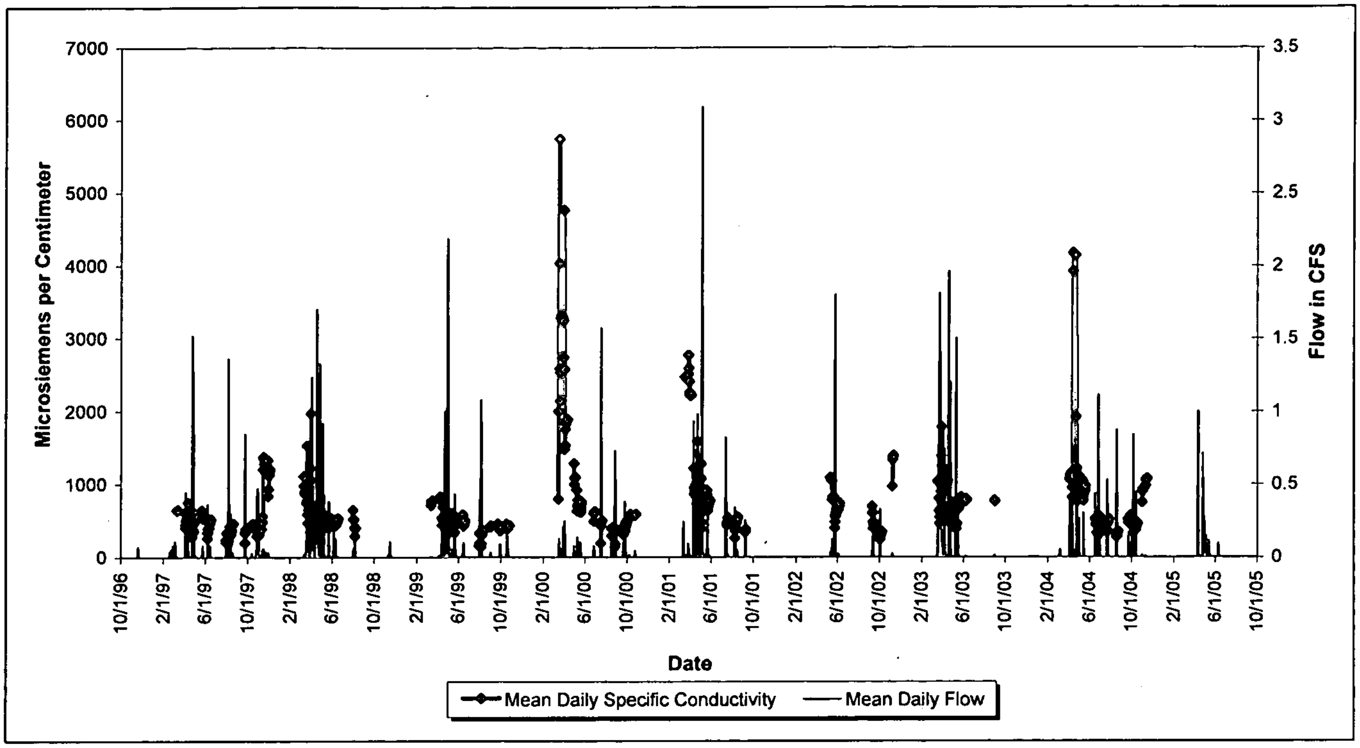


Figure 10-28. Mean Daily Specific Conductivity at SW027: WY97-05.

Figure 10-29 and Figure 10-30 show the mean daily pH varying between 7.2 and 8.2.

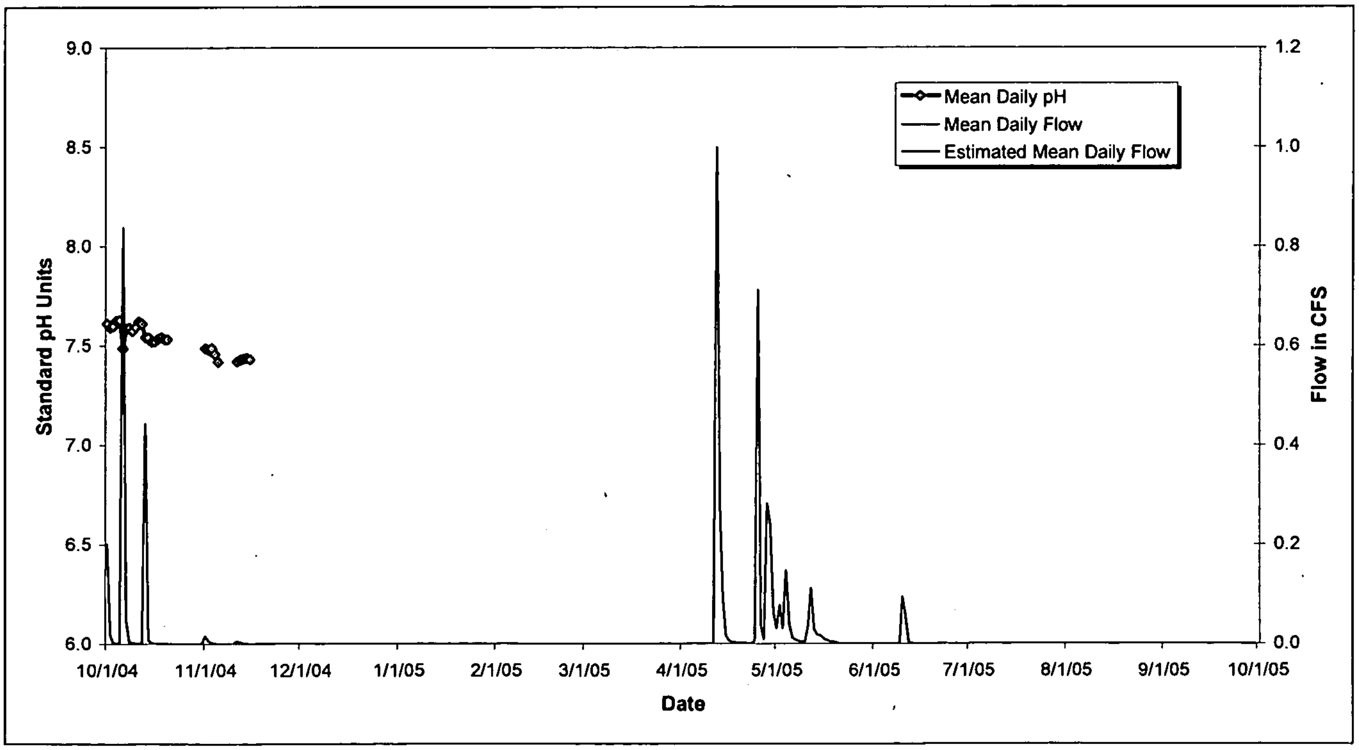


Figure 10-29. Mean Daily pH at SW027: WY05.

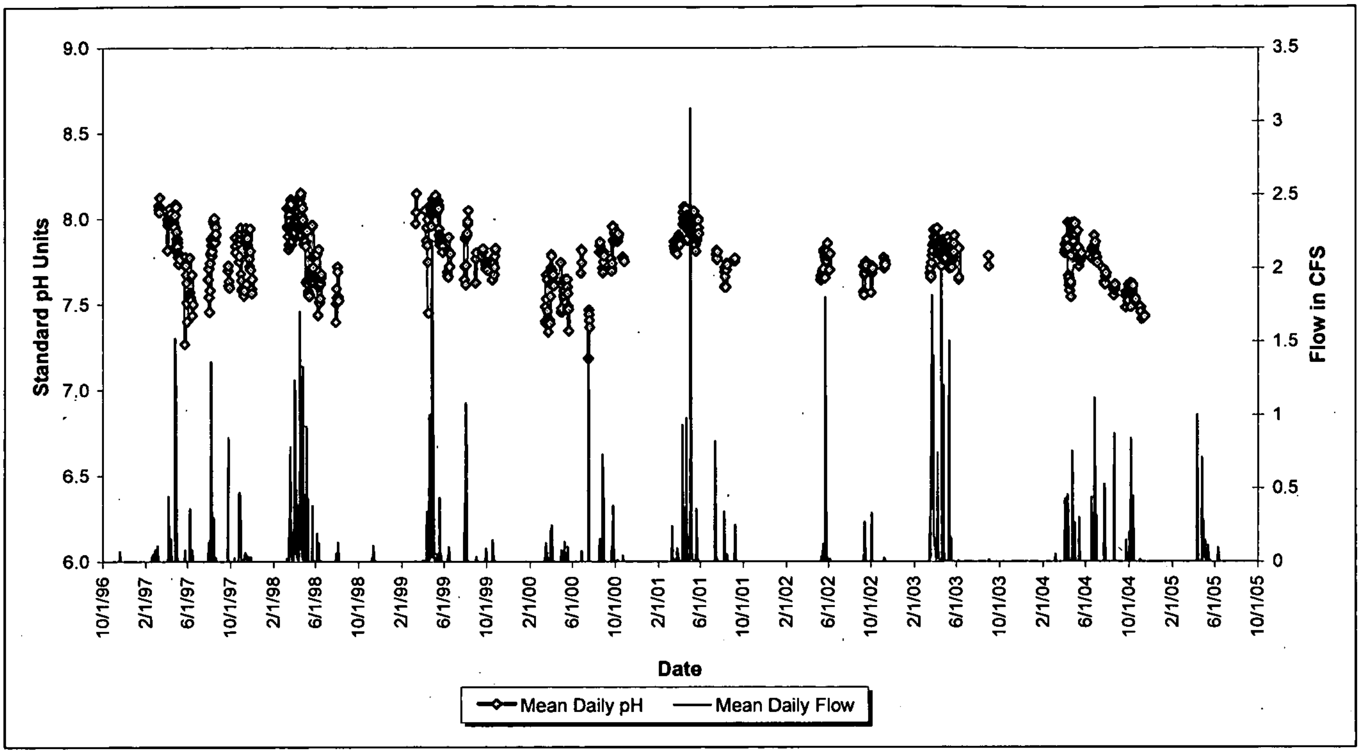


Figure 10-30. Mean Daily pH at SW027: WY97-05.

Finally, Figure 10-31 and Figure 10-32 show elevated turbidity measurements tracking the flow rate in time and magnitude, as expected when higher flow rates transport more suspended solids. WY04 shows measurably higher turbidities due to increased transport of solids from disturbed soils associated with Closure activities.

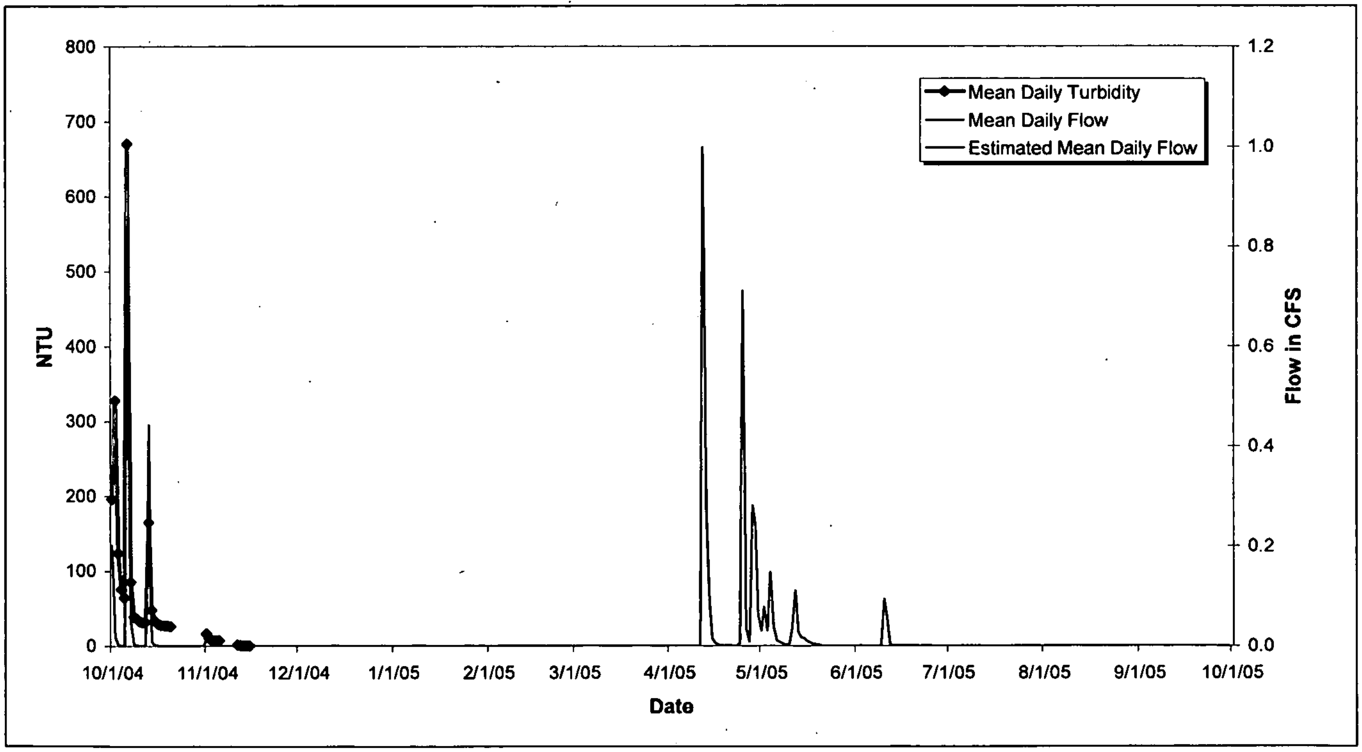


Figure 10-31. Mean Daily Turbidity at SW027: WY05.

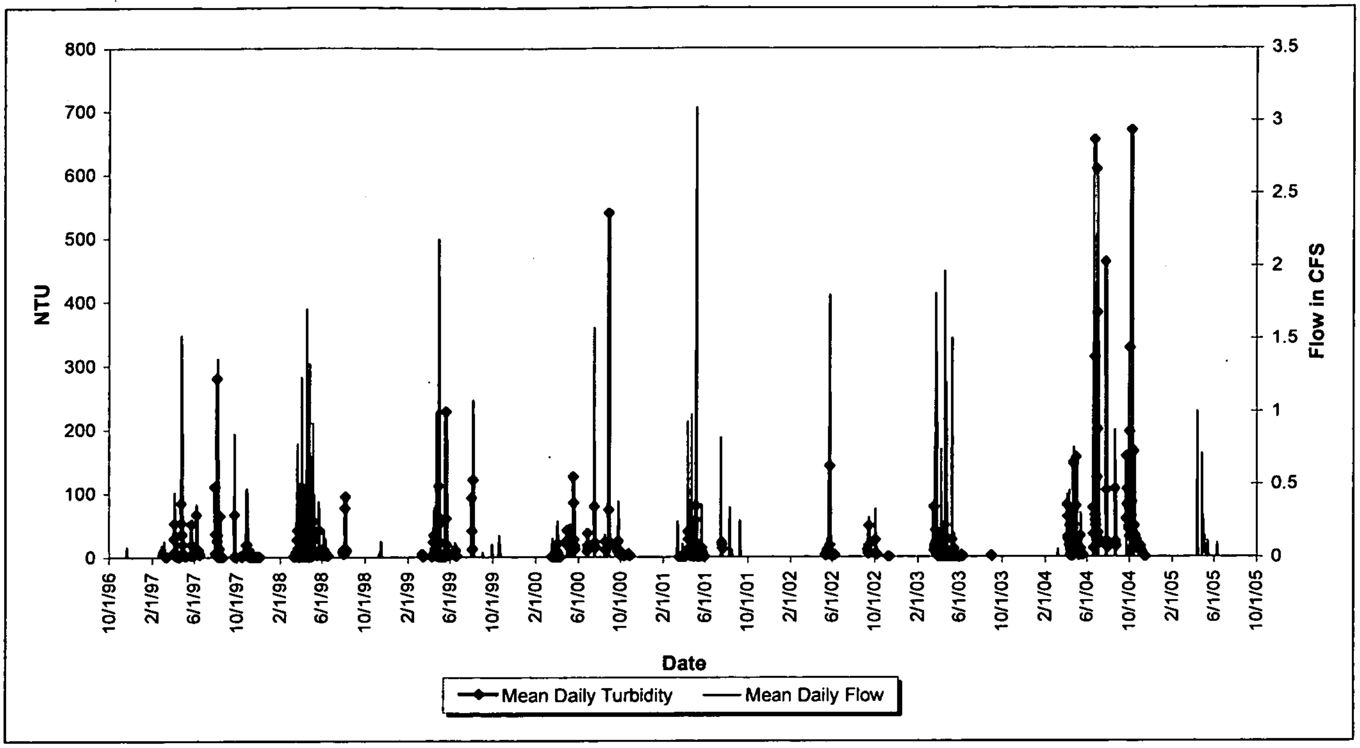


Figure 10-32. Mean Daily Turbidity at SW027: WY97-05.

10.3.4 Location SW091

Monitoring location SW091 is located at the end of a small drainage swale tributary to North Walnut Creek. Figure 3-122 shows the drainage area for SW091. The area east of the Solar Ponds contributes runoff to SW091. Operation of SW091 was discontinued on 9/7/05.

Monitoring data collected at SW091 show low median Pu and Am activities, though some higher results have been obtained (Figure 10-36). Figure 10-33 and Figure 10-34 show the UTL plots for Pu and Am, respectively. During WY03–05, no Pu or Am results were greater than the calculated UTLs, with moderate variability in the results. It should be noted that Pu and Am show measurable increases in WY04-05 due to increased transport of disturbed soils associated with Closure activities.

Table 10-10 shows low total uranium activities at SW091. During WY03-05, no results were greater than the UTLs (Figure 10-35).

The temporal variation of suspended solids activity (Figure 10-37) shows recent visual increases based on linear regression in TSS activity (pCi/g), especially for Am. This increase may be the result of the regrading of the Solar Ponds Area (completed 12/02) and the increased mobilization of contaminated soils and sediments during WY04 Closure activities.

Table 10-10. Summary Statistics for Radionuclide Results from SW091: WY03-05.

Analyte	Samples [N]	Median [pCi/L]	85th Percentile [pCi/L]	Maximum [pCi/L]	95% UTL [pCi/L]
Pu-239,240	12	0.032	0.153	0.255	0.715[a]
Am-241	12	0.036	0.175	0.412	0.755[a]
Total Uranium	12	1.92	3.11	7.75	16.5[a]

Note: Total uranium is calculated as the sum of the isotopic (U-233,234; U-235; U-238) activities.
[a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.

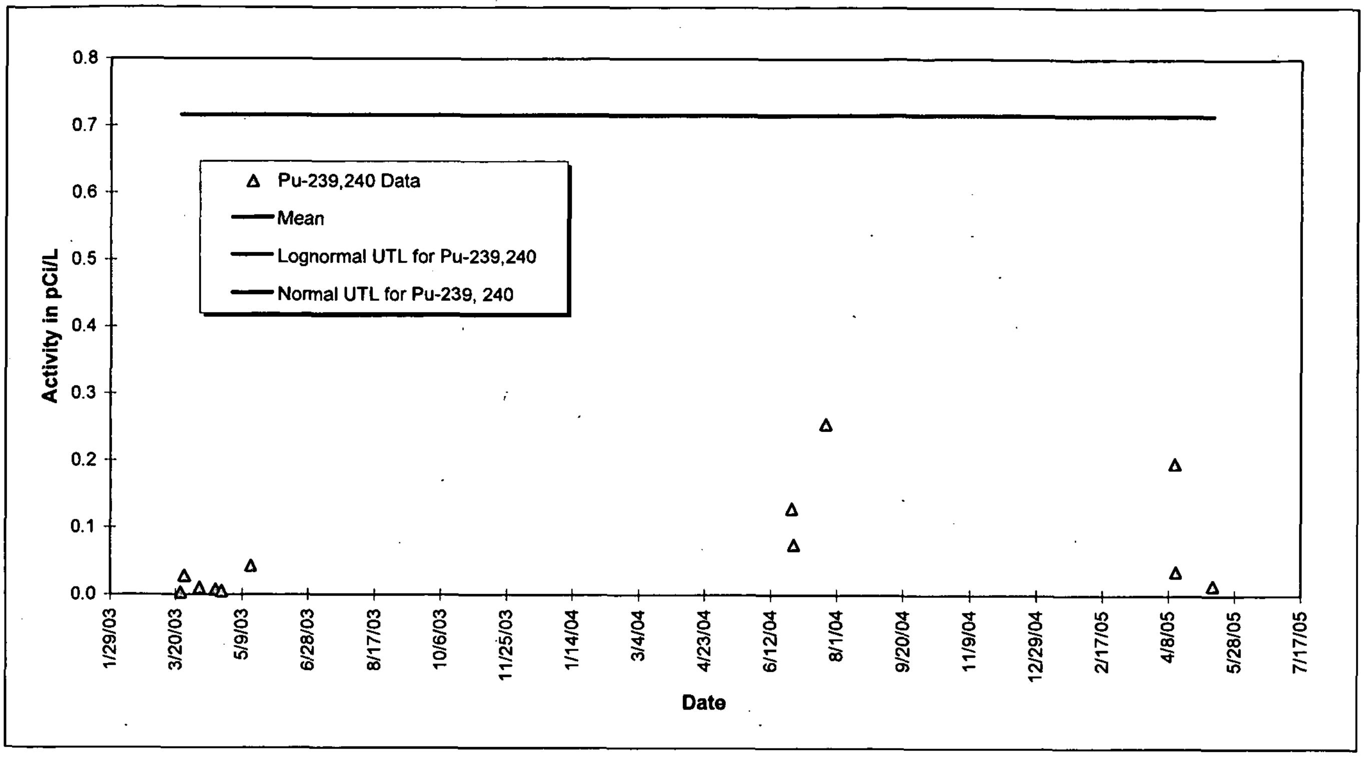


Figure 10-33. 95% UTL Plot for Pu-239,240 at SW091: WY03-05.

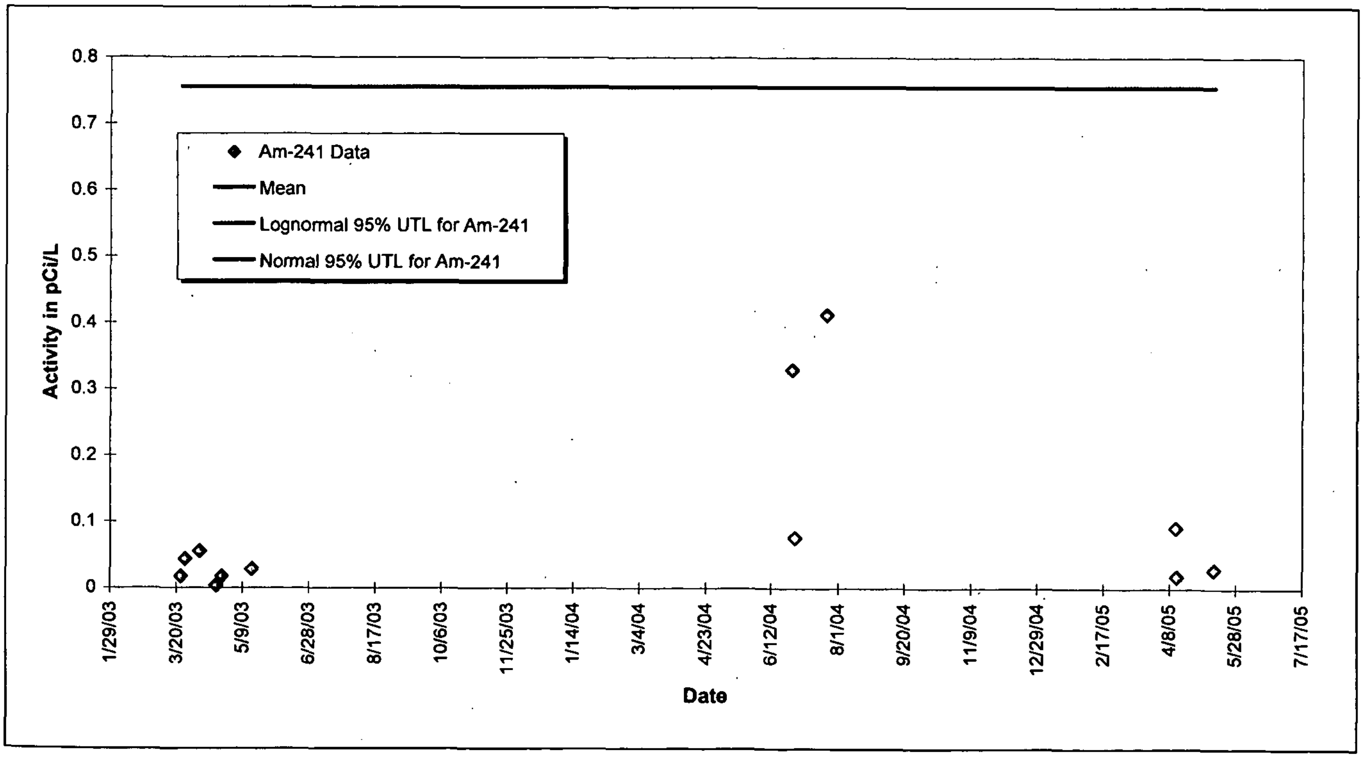


Figure 10-34. 95% UTL Plot for Am-241 at SW091: WY03-05.

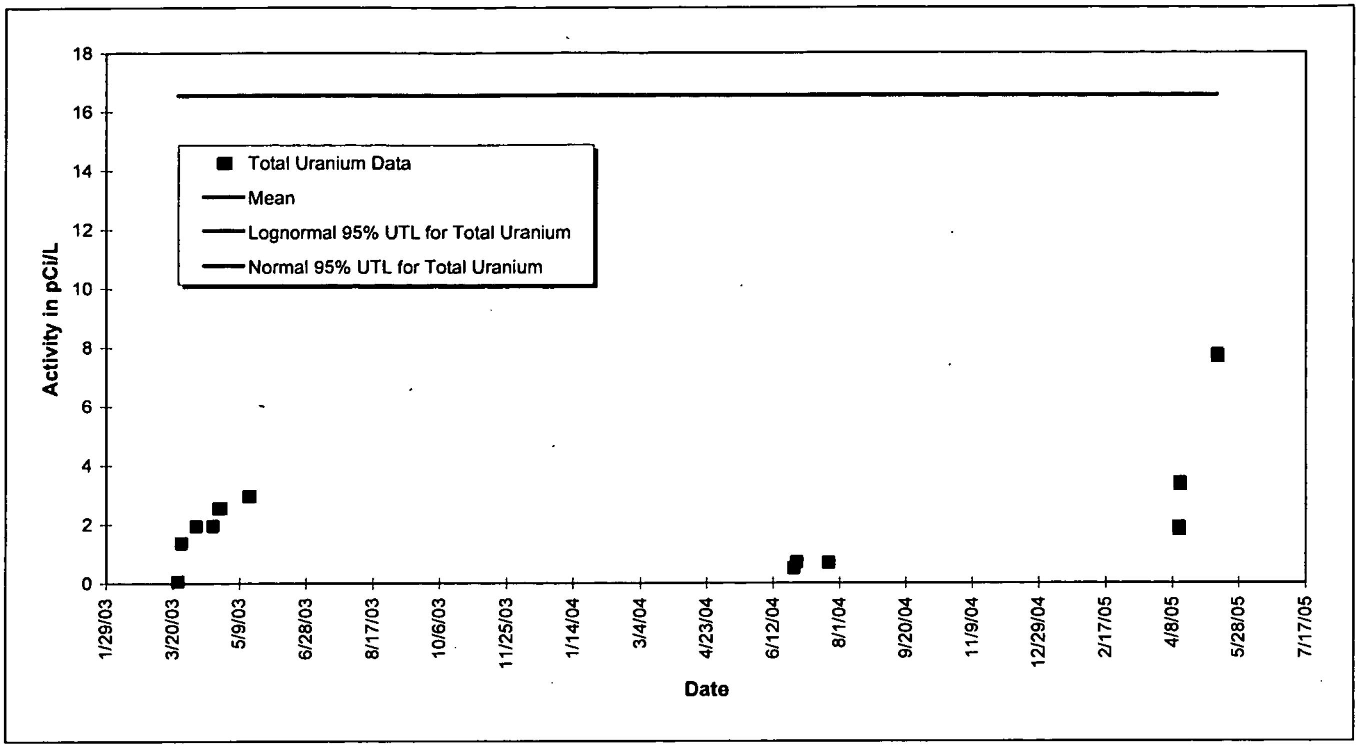


Figure 10-35. 95% UTL Plot for Total Uranium at SW091: WY03-05.

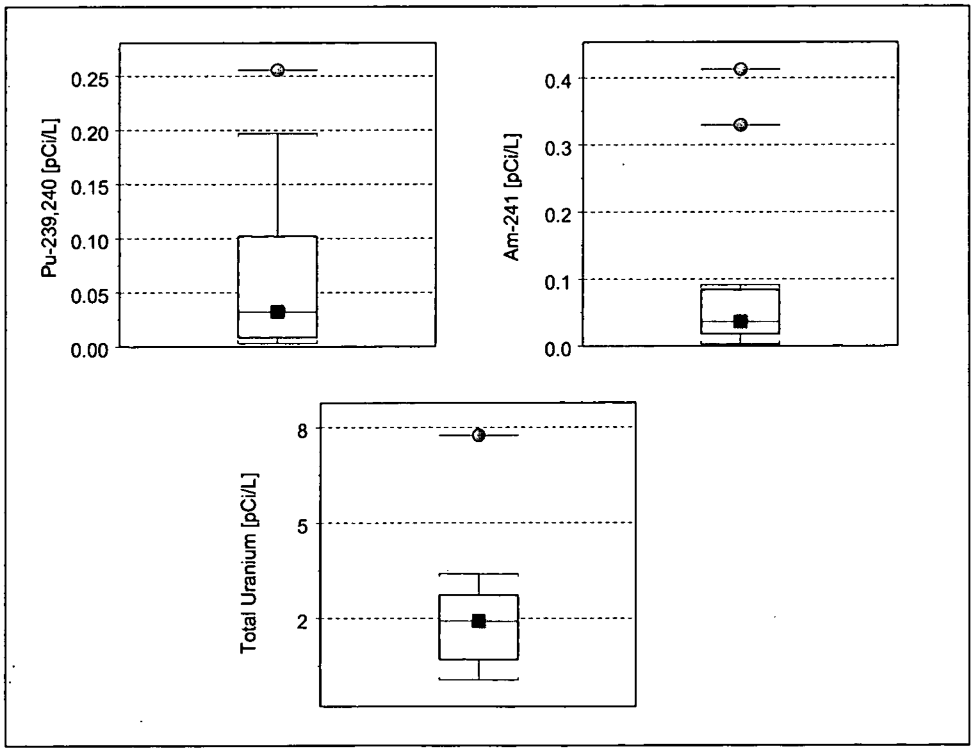


Figure 10-36. Radionuclide Box Plots for SW091: WY03–05.

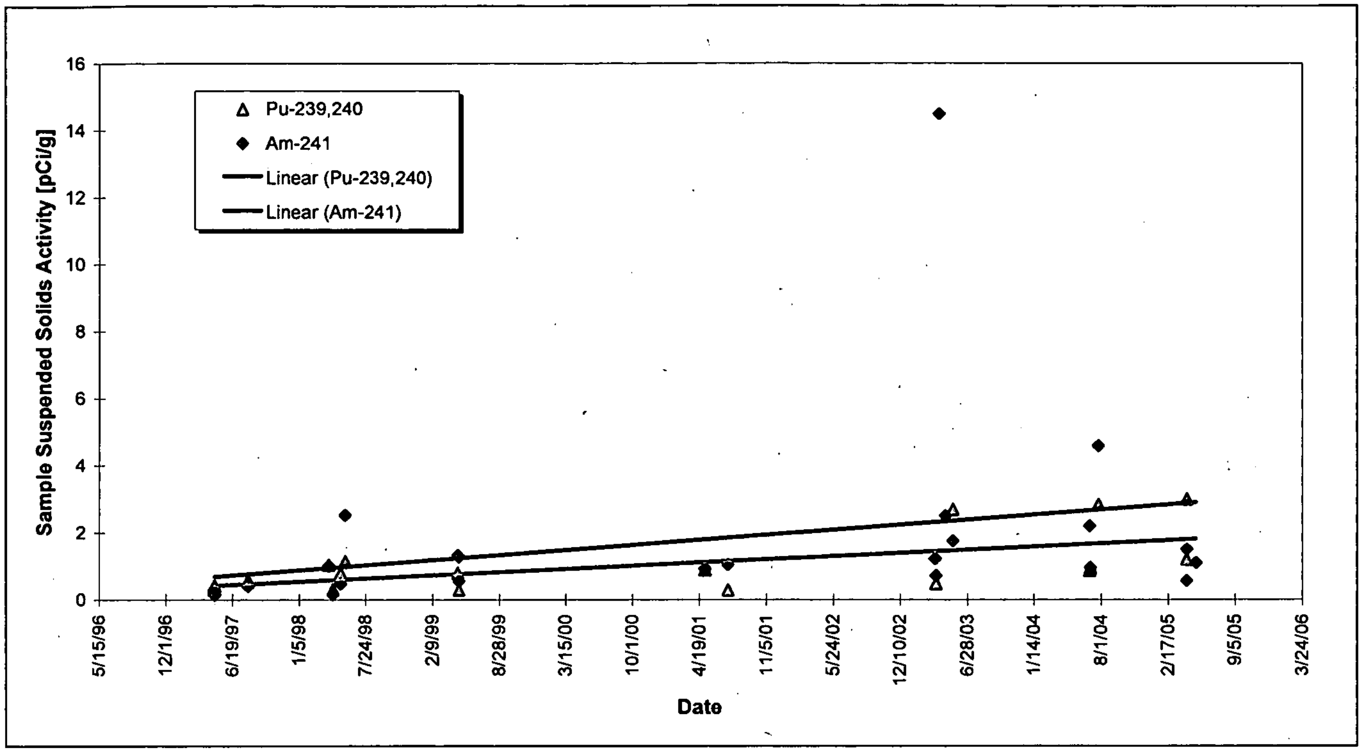


Figure 10-37. Temporal Variation of Suspended Solids Activity at SW091: WY97–05.

10.3.5 Location SW093

Monitoring location SW093 is located on North Walnut Creek at the perimeter of the IA 1300' upstream of the A-Series Ponds. Figure 3-125 shows the drainage area for SW093. The 100, 300, 500, 700, and 900 areas all contribute flow to SW093.

Monitoring data collected at SW093 show the highest Am activities measured for the NSD monitoring locations (Table 10-11). Monitoring data collected at SW093 show moderate median Pu activities (Table 10-11), although several higher results have been obtained (Figure 10-41). Figure 10-38 and Figure 10-39 show the UTL plots for Pu and Am, respectively. During WY03–05, a single Pu and Am result was greater than the calculated UTL, with significant variability in the results. These higher Pu and Am activities resulted in reportable 30-day averages under the POE monitoring objective (Section 11). In response, the Site was required to perform source evaluations to address these reportable values. A summary of the extensive investigations is given in Section 6.3.3. Source evaluation for POE SW093 identified runoff from the B779 area as the primary contributor of Pu load in WY04, with construction of Functional Channels #2/3 as the cause of the WY05 reportable Pu values. Source evaluation also identified B771 as the primary contributor of Am load in WY04-05. With the completion of the functional channels, elimination of the B771 pathway, implementation of enhanced erosion controls, revegetation, and soil stabilization, transport of Pu and Am approaching the action level has been virtually eliminated.

Table 10-11 shows low uranium activities at SW093. The UTL plot (Figure 10-40) shows three recent results exceeding the calculated UTL, with the suggestion of a recent visually increasing trend. Hydrologic changes at SW093, as identified for GS10, are likely the cause of the increases in total uranium. As impervious areas were removed at the Site (reducing direct runoff during precipitation events), groundwater contributions to the creek with naturally occurring uranium represent a larger portion of the streamflow monitored at SW093. Without direct runoff contributions to attenuate the groundwater uranium contributions, samples from SW093 will reflect the naturally occurring groundwater uranium concentrations (often significantly greater than the surface-water action level).

Since 1999, RFETS groundwater and surface water samples from select locations have been sent to Los Alamos National Laboratory for high resolution inductively coupled mass spectrometry (HR ICP/MS) and/or thermal ionization mass spectrometry (TIMS) analyses. These analyses measure mass ratios of the four uranium isotopes (masses 234, 235, 236, and 238) and are detailed in the reports titled "Uranium in Surface Soil, Surface Water, and Groundwater at the Rocky Flats Environmental Technology Site, dated June 2004" and in the "Interim Measure/Interim Remedial Action for Groundwater at the Rocky Flats Environmental Technology Site, dated June 21, 2005". Isotopic ratios provide a signature that indicates whether the source of uranium is natural or anthropogenic (man-made). The results to date indicate that all the groundwater and surface-water locations at the Site display a predominately natural signature.

SW093 shows a visually increasing temporal trend based on linear regression in suspended solids activity, due to short-term increased transport in WY04 (Figure 10-42). WY05 data show a return to more 'normal' levels.

Table 10-11. Summary Statistics for Radionuclide Results from SW093: WY03-05.

Analyte	Samples [N]	Median [pCi/L]	85^{th} Percentile [pCi/L]	Maximum [pCi/L]	95% UTL [pCi/L]
Pu-239,240	85	0.032	0.363	4.180	4.00[a]
Am-241	82	0.029	0.294	14.1	2.94[a]
Total Uranium	84	3.04	4.31	7.33	5.60[b]

Note: Total uranium is calculated as the sum of the isotopic (U-233,234; U-235; U-238) activities.
[a] Lognormal distribution; [b] Normal distribution; [c] Undetermined distribution.

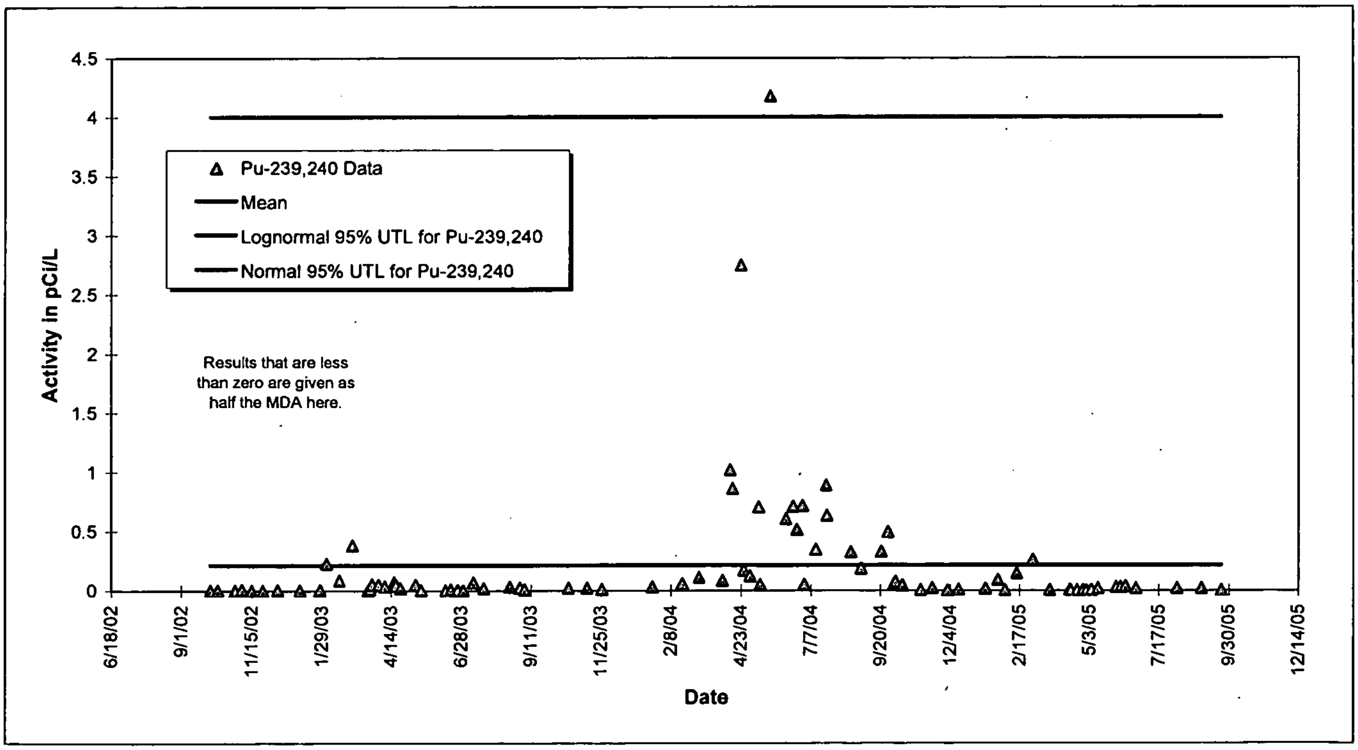


Figure 10-38. 95% UTL Plot for Pu-239,240 at SW093: WY03-05.

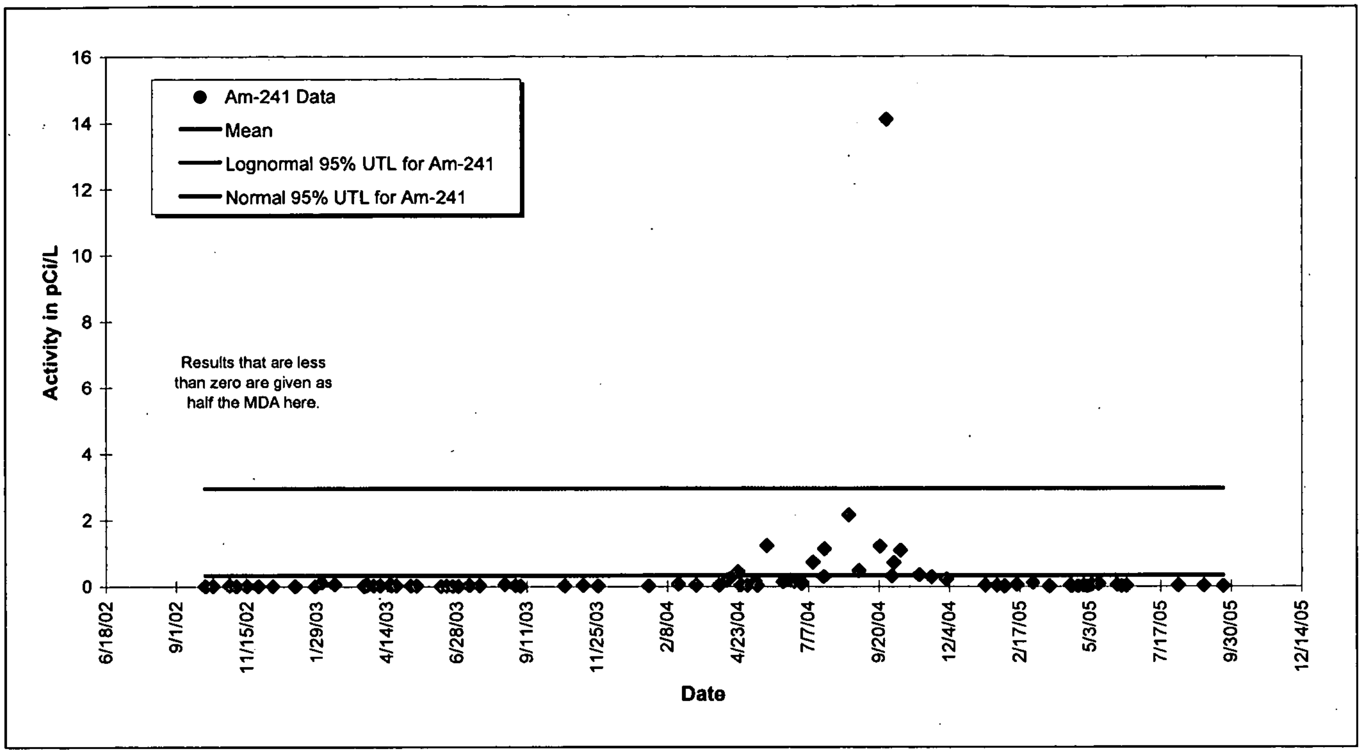


Figure 10-39. 95% UTL Plot for Am-241 at SW093: WY03-05.

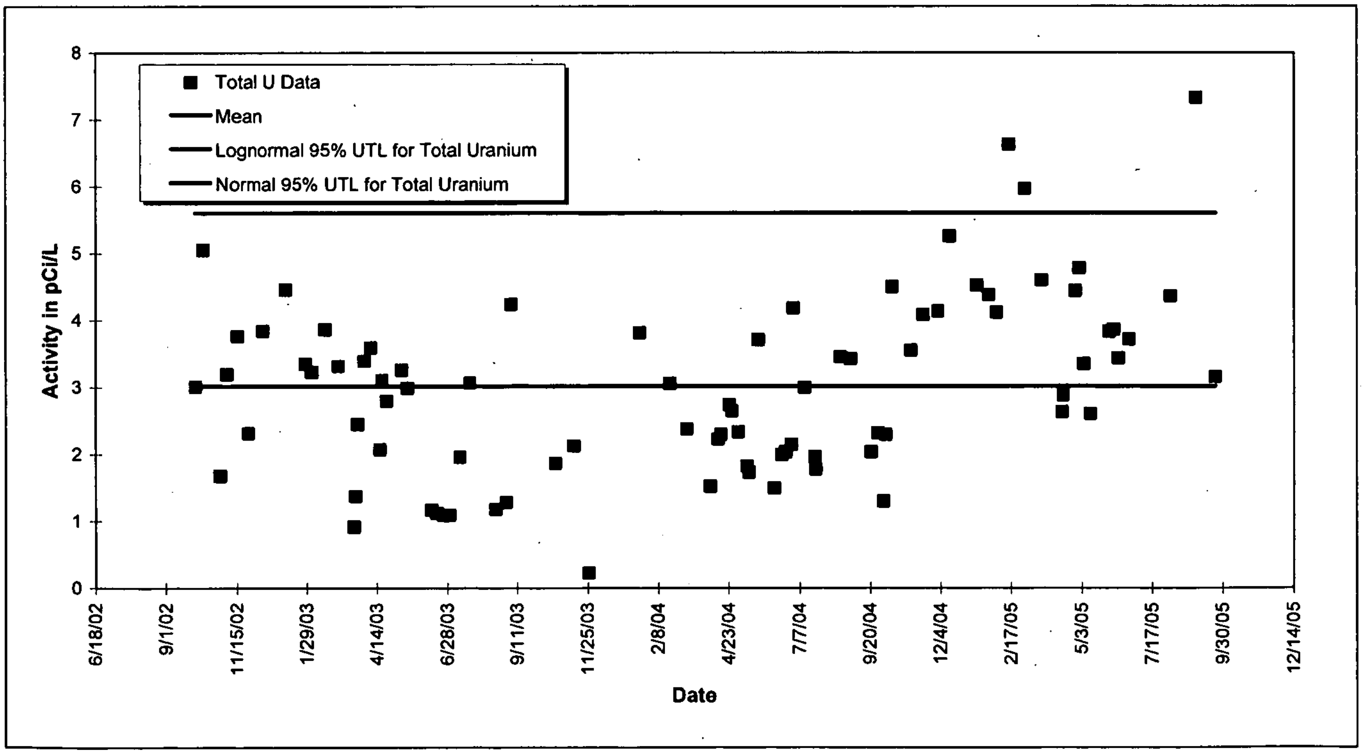


Figure 10-40. 95% UTL Plot for Total Uranium at SW093: WY03-05.

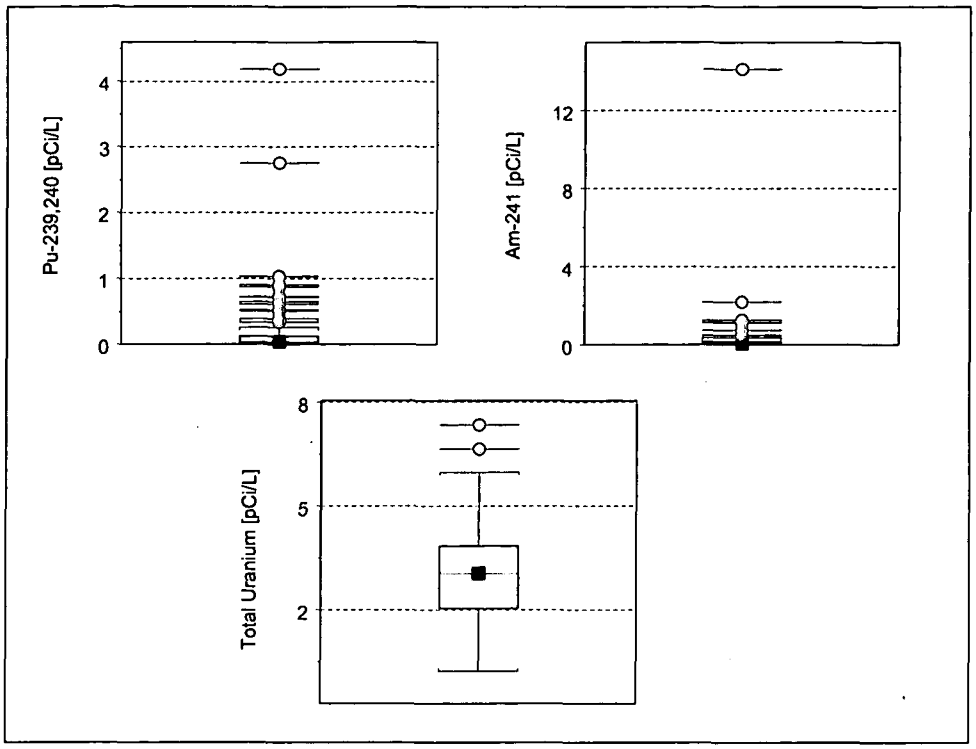


Figure 10-41. Radionuclide Box Plots for SW093: WY03–05.

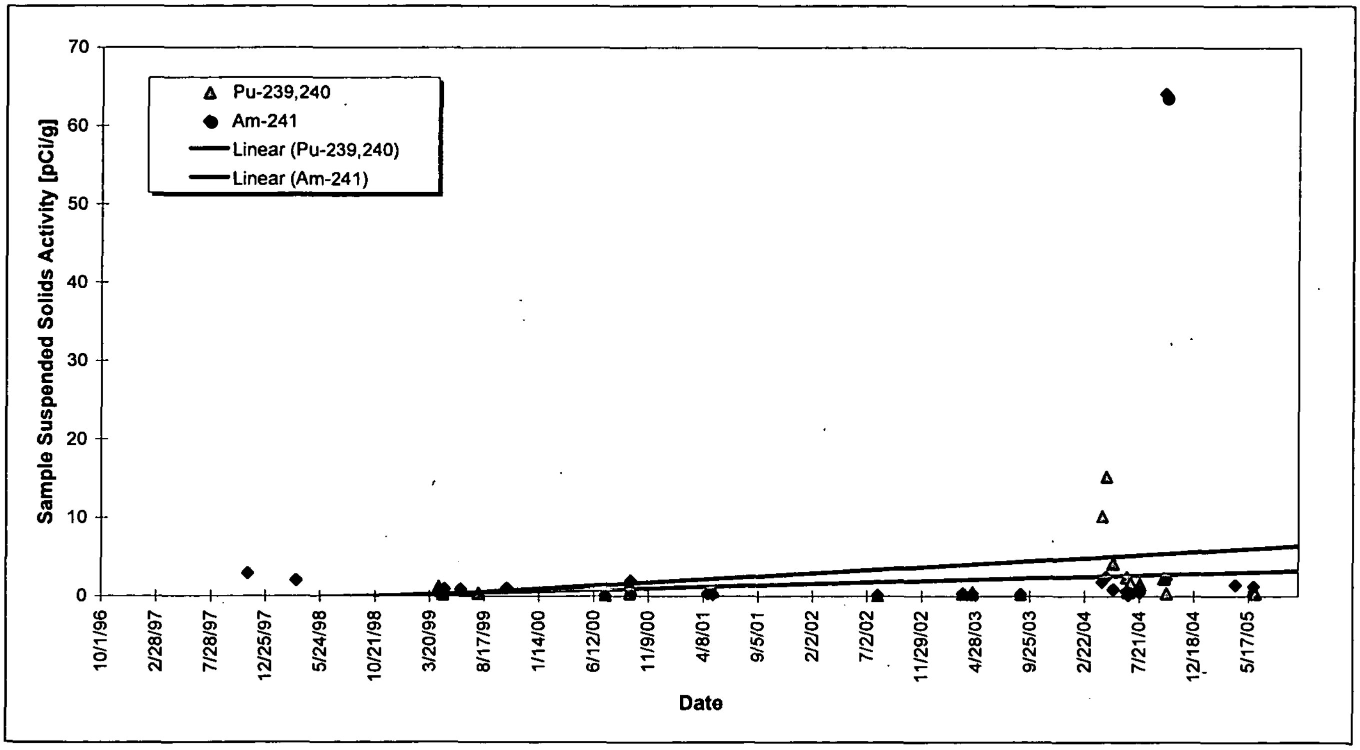


Figure 10-42. Temporal Variation of Suspended Solids Activity at SW093: WY97–05.

Mean daily water-quality parameter data are plotted in Figure 10-43 through Figure 10-50 along with the mean daily flow rate. Figure 10-43 and Figure 10-44 show the expected annual variation in water temperature.

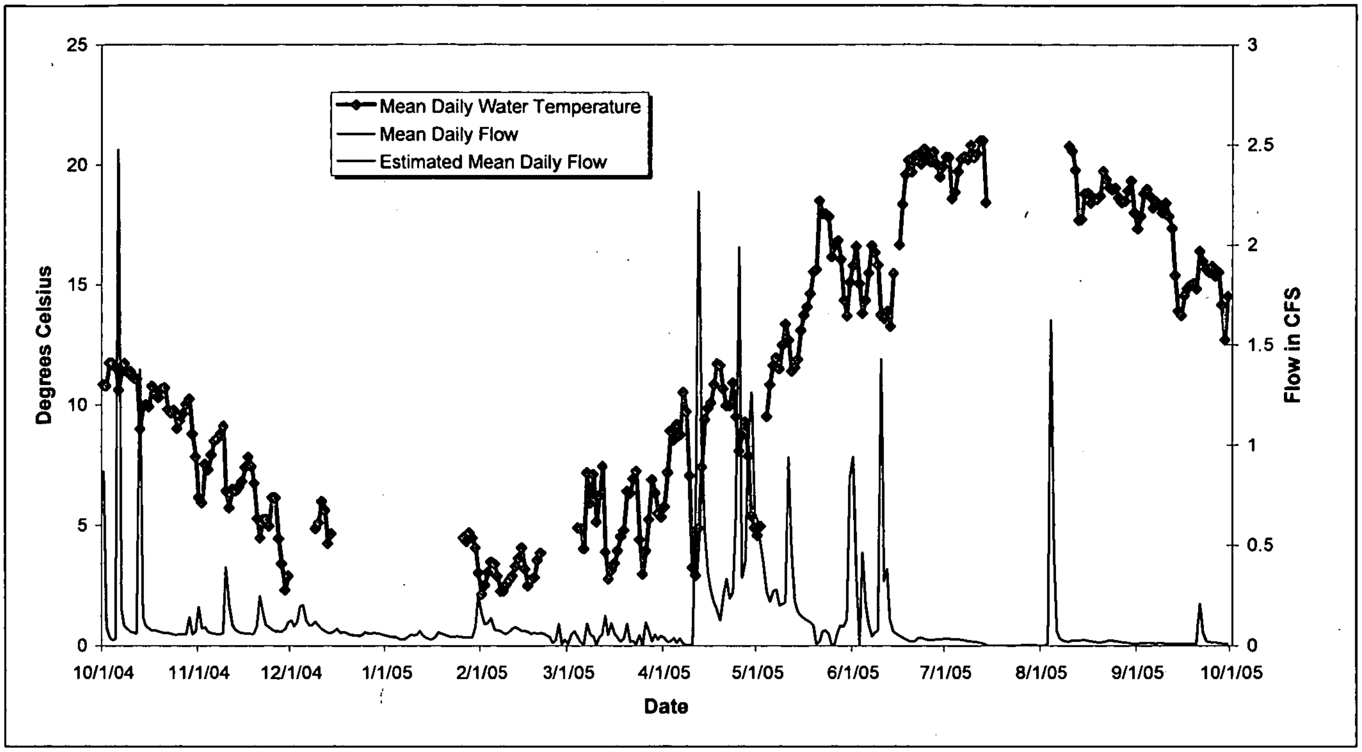


Figure 10-43. Mean Daily Water Temperature at SW093: WY05.

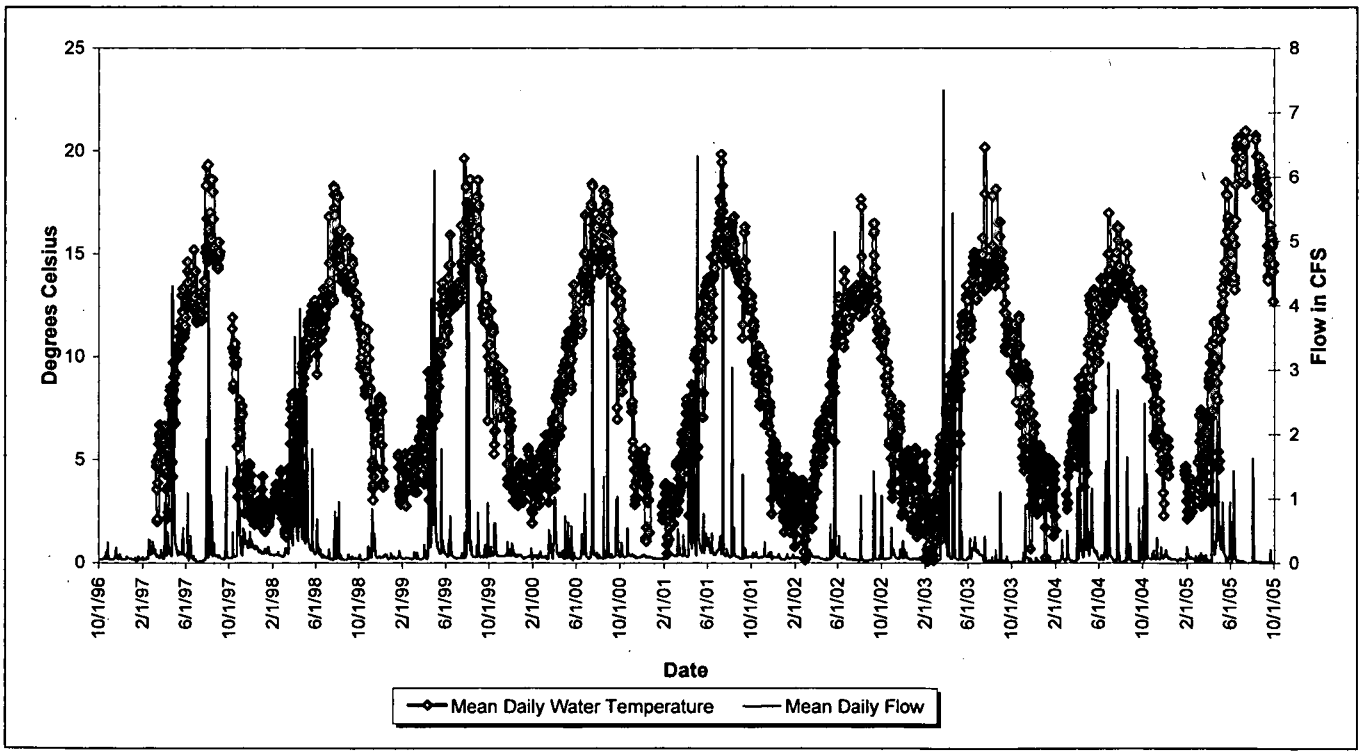


Figure 10-44. Mean Daily Water Temperature at SW093: WY97-05.

Figure 10-45 and Figure 10-46 show elevated conductivities during the winter months, most likely a result of road and walkway deicing operations. The effects of changes in deicing products (magnesium chloride) starting in WY00 can be clearly seen in Figure 10-46 as increased conductivity.

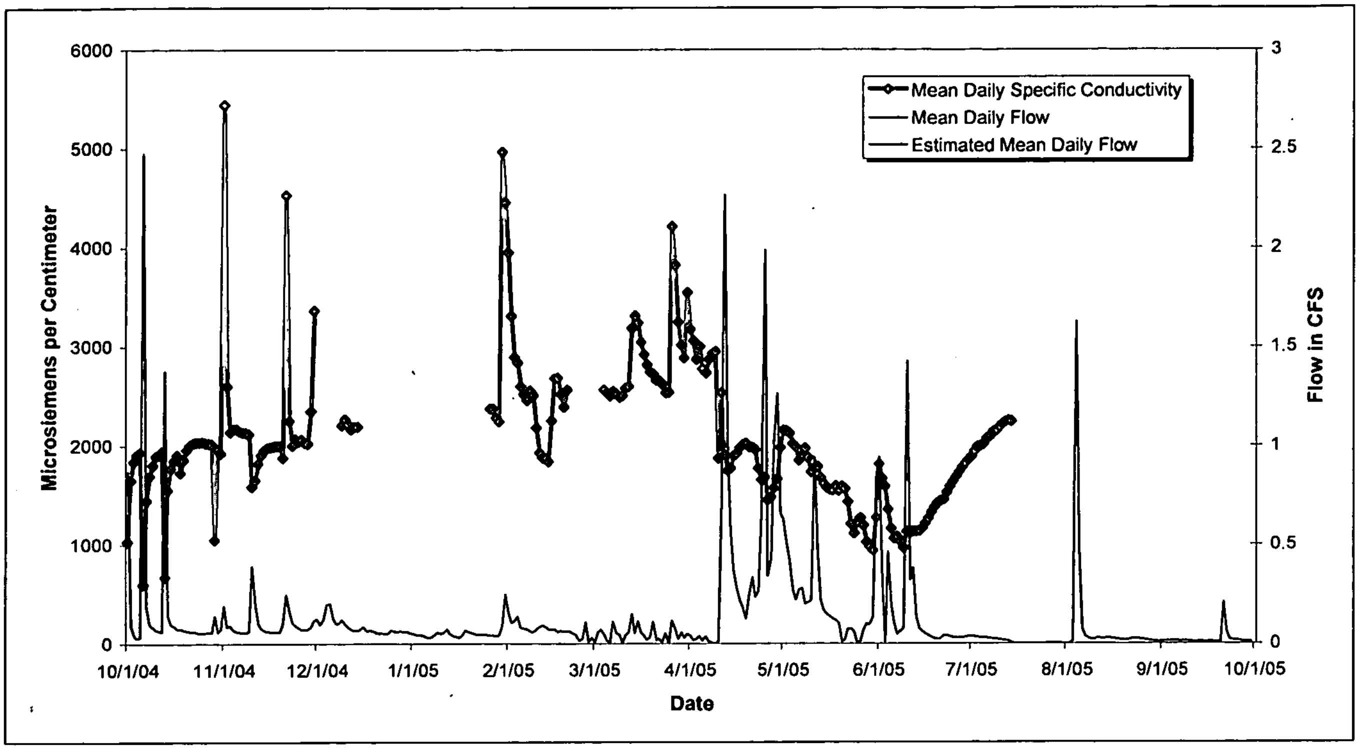


Figure 10-45. Mean Daily Specific Conductivity at SW093: WY05.

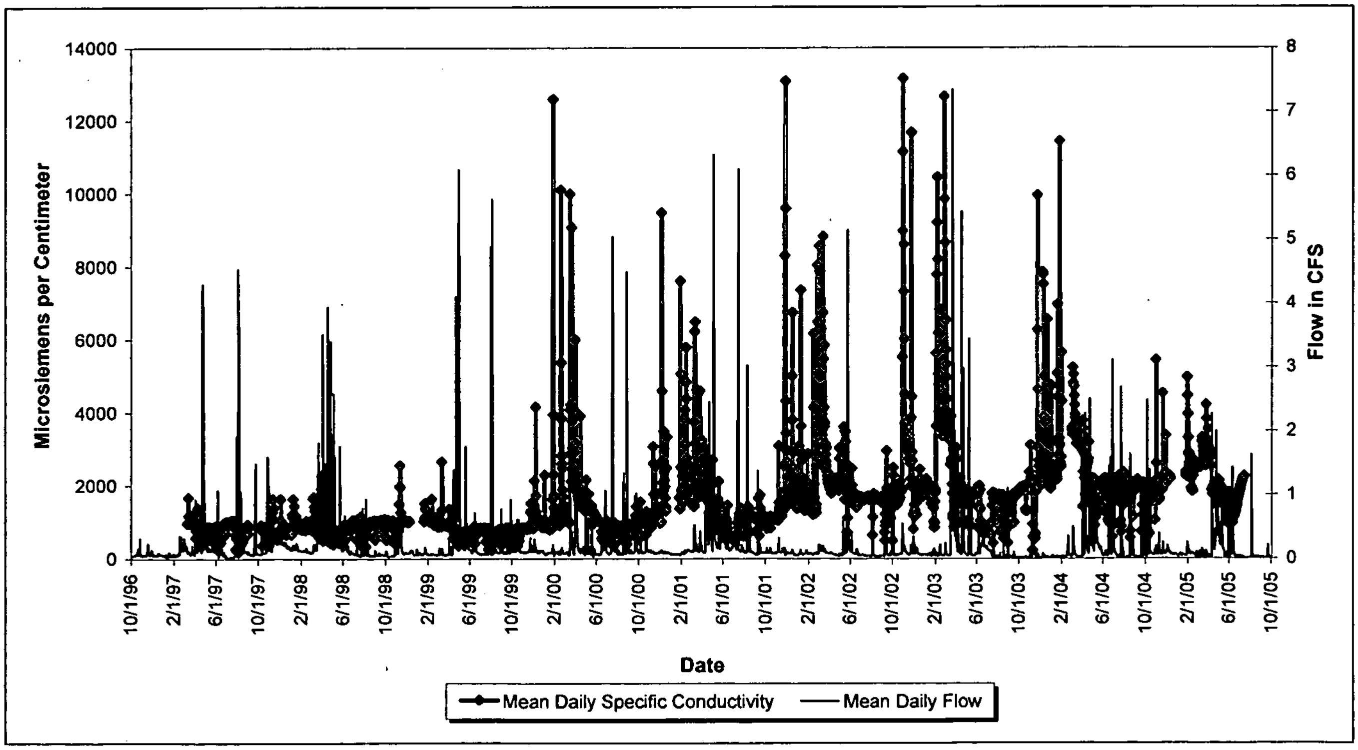


Figure 10-46. Mean Daily Specific Conductivity at SW093: WY97-05.

Figure 10-47 and show the mean daily pH varying between 6.8 and 8.4.

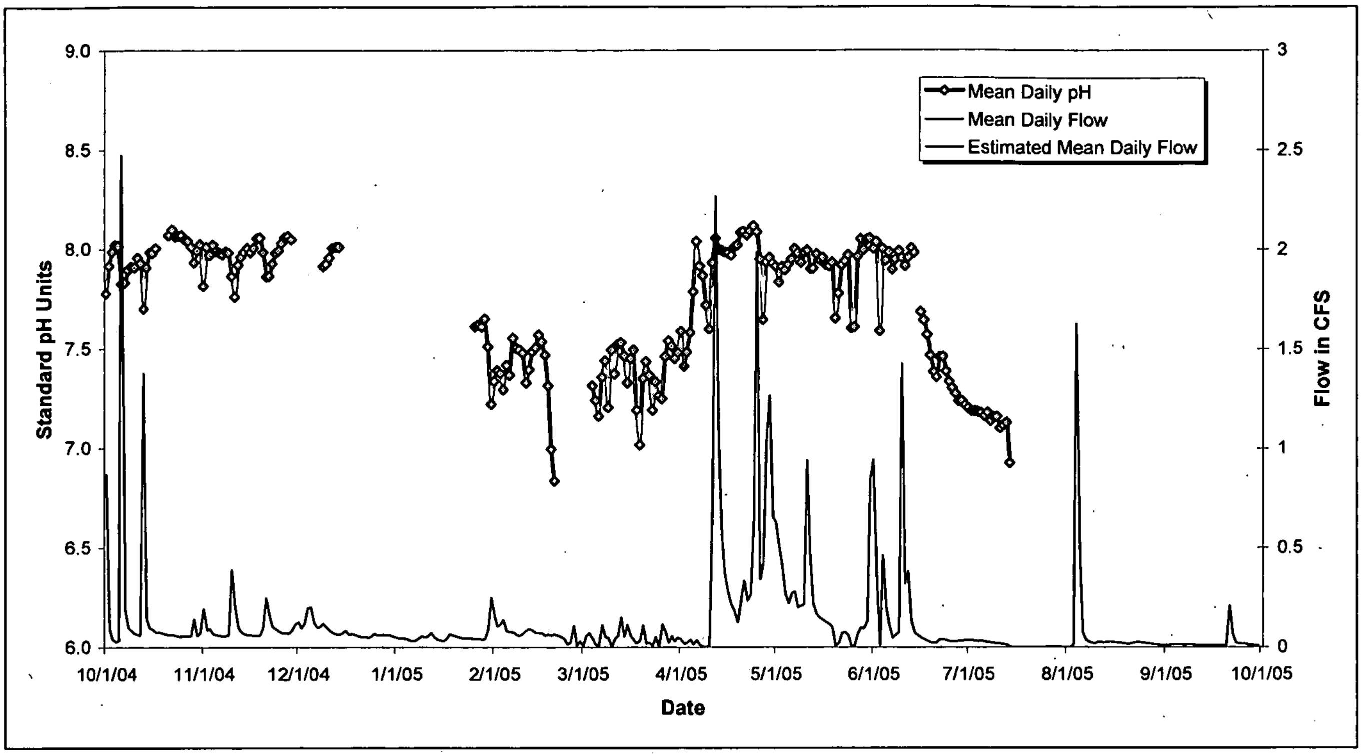


Figure 10-47. Mean Daily pH at SW093: WY05.

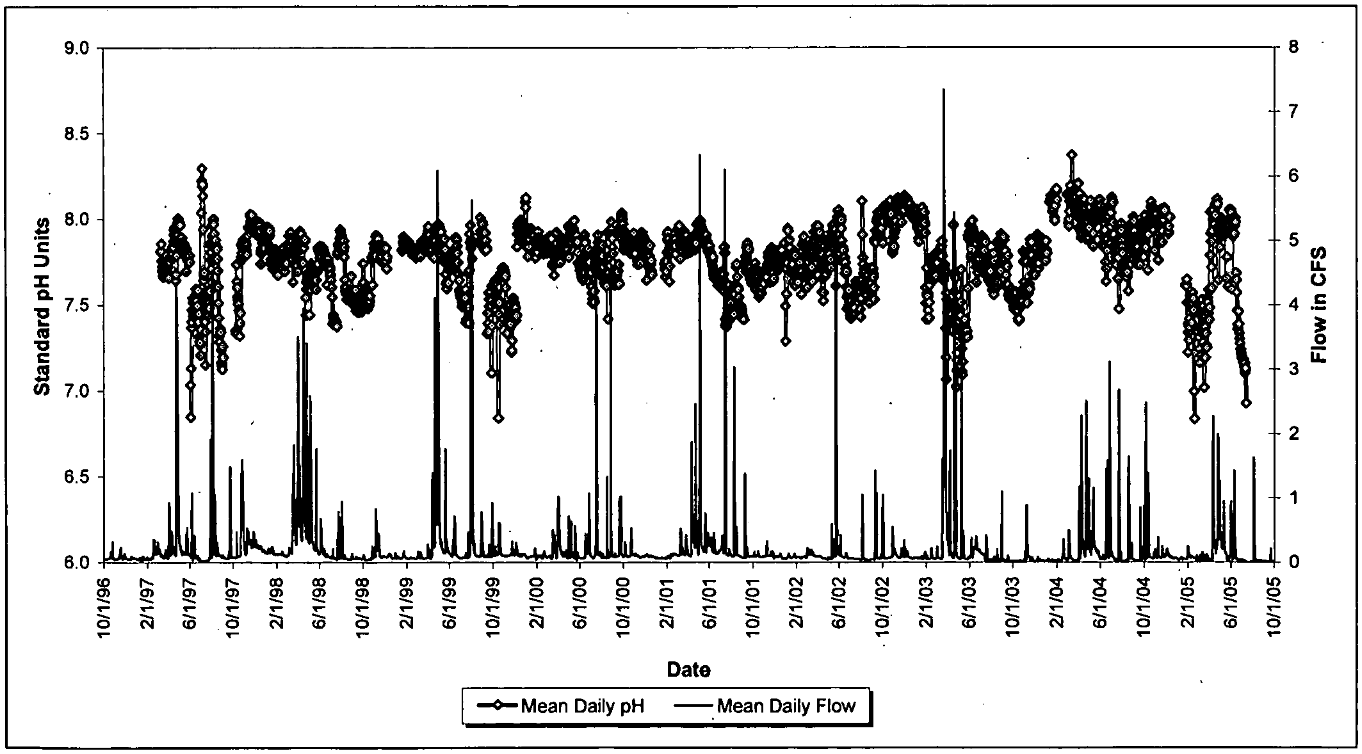


Figure 10-48. Mean Daily pH at SW093: WY97-05.

Finally, Figure 10-49 and Figure 10-50 show elevated turbidity measurements tracking the flow rate in time and magnitude, as expected when higher flow rates transport more suspended solids. WY04-05 shows measurably higher turbidities due to increased transport of solids from disturbed soils associated with Closure activities. The majority of the turbidity data after completion of the functional channels show low levels.

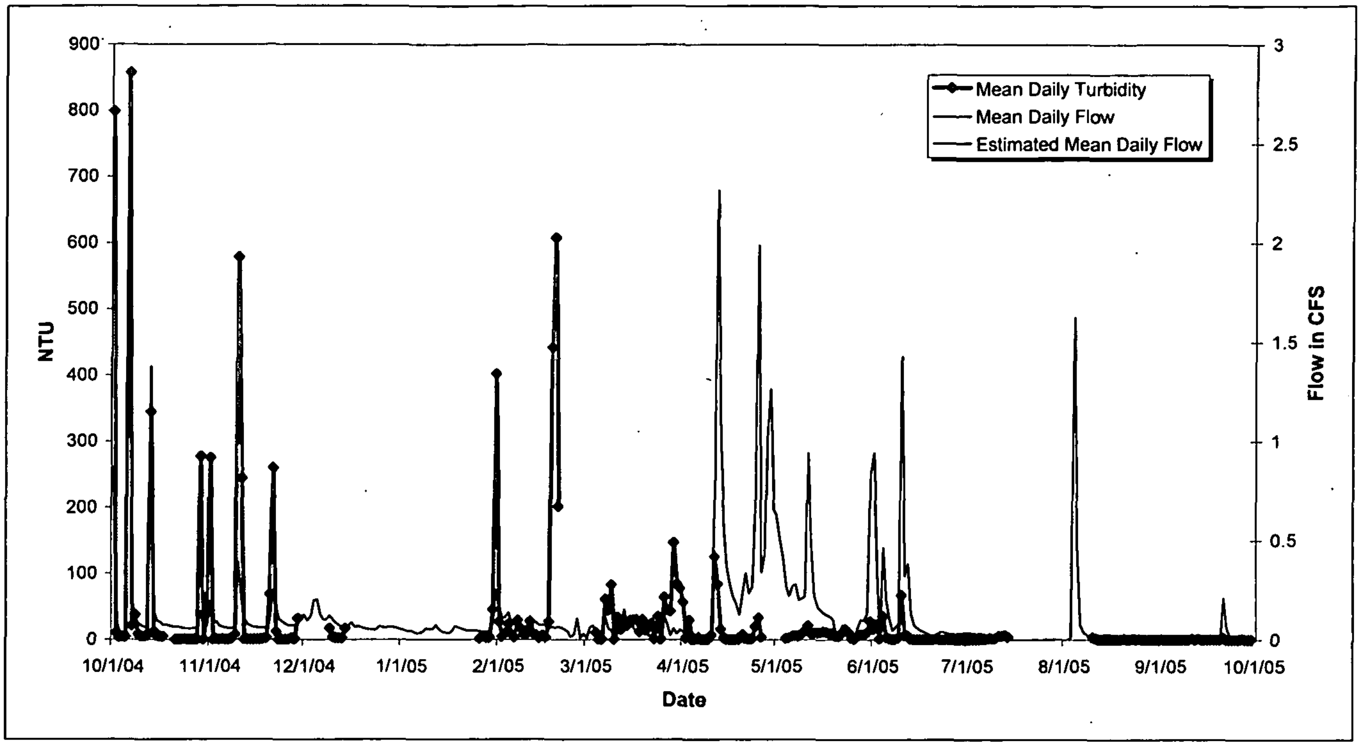


Figure 10-49. Mean Daily Turbidity at SW093: WY05.

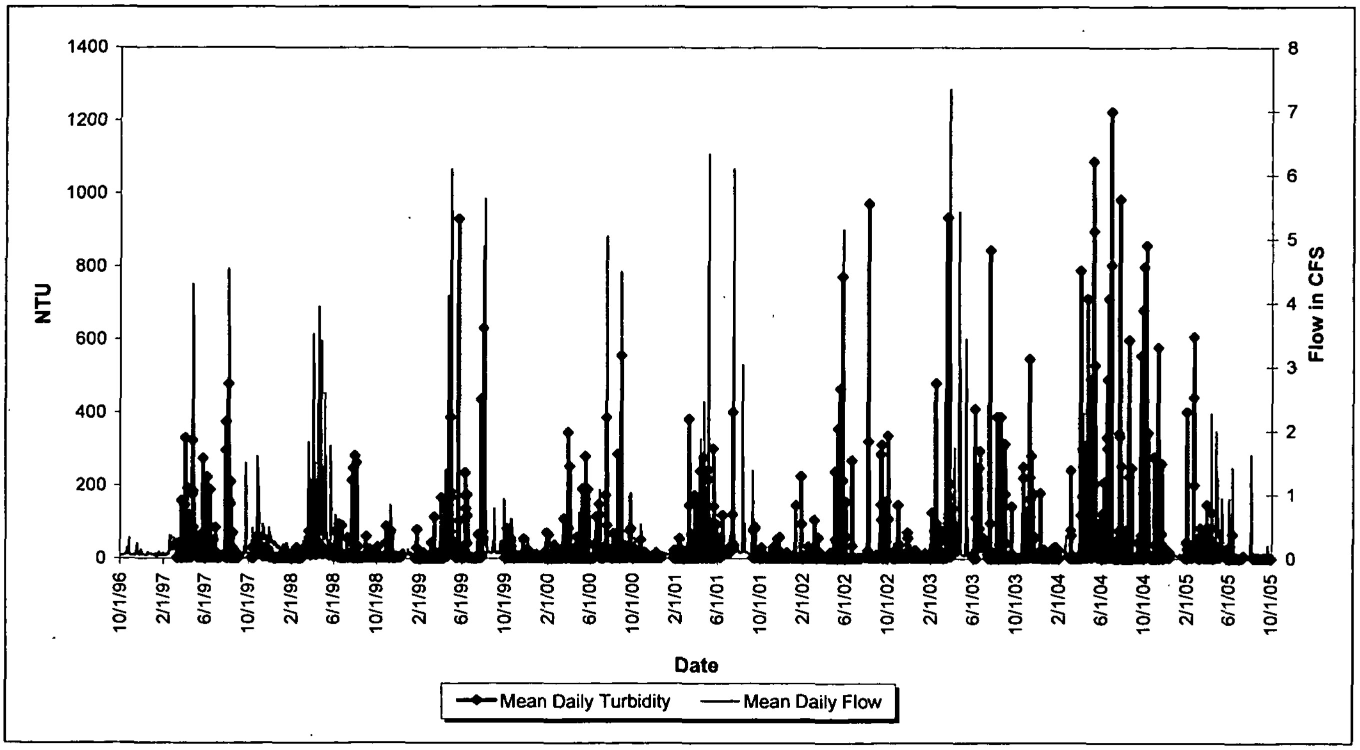


Figure 10-50. Mean Daily Turbidity at SW093: WY97-05.

10.4 NEW SOURCE DETECTION SUMMARY

10.4.1 Location GS10

- During WY05–05, a single Am result was greater than the calculated UTL, with significant variability in the results. The higher Pu and Am activities resulted in reportable 30-day averages under the POE monitoring objective (Section 11). In response, the Site was required to continue the ongoing source evaluations to address these reportable values. A summary of the extensive investigations is given in Section 6.3.2.
- During WY03–05, recent uranium results are greater than the calculated UTLs, with a visual upward trend. These values resulted in reportable 30-day averages under the POE monitoring objective (Section 11). A summary of the extensive investigations is given in Section 6.3.2. Source evaluation at GS10 identified hydrologic changes at GS10 as the cause of the increases in total uranium.
- GS10 shows a visually decreasing trend in suspended solids activity for both Pu and Am suggesting a reduction of contamination levels in the GS10 drainage.

10.4.2 Location SW022

- During WY03–05, no Pu or Am results exceeded the calculated UTL. It should be noted that Pu and Am both show measurable increases in WY04 due to increased transport of disturbed soils associated with Closure activities.
- Monitoring data collected at SW022 show low median total uranium activities. A distribution for total uranium could not be determined. However, all measured values are low.
- SW022 shows a visually decreasing trend in suspended solids activity for both Pu and Am suggesting a reduction of contamination levels in the SW022 drainage.

10.4.3 Location SW027

- During WY03–05, a distribution could not be determined for either Pu or Am, with significant variability in the results. The higher Pu and Am activities in WY04-05 resulted in reportable 30-day averages under the POE monitoring objective (Section 11). In response, the Site was required to perform source evaluations to address these reportable values. A summary of the extensive investigations is given in Section 6.3.4.
- During WY03-05, a single total uranium result was greater than the UTL, though the value was low and no subsequent data are available to assess a trend.
- SW027 shows an increasing temporal trend in suspended solids activity, due to short-term increased transport from the 903 Pad/Lip, for the few TSS results obtained. WY05 data show a return to more 'normal' levels.

10.4.4 Location SW091

- During WY03–05, no Pu or Am results were greater than the calculated UTLs, with moderate variability in the results. It should be noted that Pu and Am show measurable increases in WY04-05 due to increased transport of disturbed soils associated with Closure activities.
- During WY03-05, no total uranium results were greater than the UTL.
- The temporal variation of suspended solids activity shows recent visual increases in TSS activity (pCi/g), especially for Am. This apparent increase may be the result of the regrading of the Solar Ponds Area

(completed 12/02) and the increased mobilization of contaminated soils and sediments during WY04 Closure activities.

10.4.5 Location SW093

- During WY03–05, a single Pu and Am result was greater than the calculated UTL, with significant variability in the results. These higher Pu and Am activities resulted in reportable 30-day averages under the POE monitoring objective (Section 11). In response, the Site was required to perform source evaluations to address these reportable values. A summary of the extensive investigations is given in Section 6.3.3.
- The UTL plot shows three recent results exceeding the calculated UTL, with the suggestion of a recent visually increasing trend. Hydrologic changes at SW093, as identified for GS10, are likely the cause of the increases in total uranium.
- SW093 shows a visually increasing trend in suspended solids activity, due to short-term increased transport in WY04. WY05 data show a return to more 'normal' levels.

11. STREAM SEGMENT 5 POINT OF EVALUATION MONITORING

This monitoring objective deals with POE monitoring of Segment 5 for adherence with the RFCA Action Level Framework (ALF). Responses to reportable values relative to Action Levels at POEs are different than the responses associated with contaminated runoff before it reaches Segment 5 or after it enters Segment 4. IA monitoring upgradient of Segment 5 is designed to detect new contaminant sources within the IA. Downstream, Segment 4 is monitored at POCs to protect designated uses, the ecology, and public health.

Data collected during RFCA monitoring have resulted in reportable values for Pu and Am under the RFCA action level criteria at the designated POEs. Such reportable values have required source evaluation and the development of a mitigation plan, when appropriate. These reportable values have caused the Site to invoke the Source Location decision rule, perform special monitoring tailored to the specific source evaluation, and take action upstream of Segment 5 to protect Segment 5 from contaminant sources that caused the reportable values.

11.1 DATA TYPES, FREQUENCY, AND COLLECTION PROTOCOLS

The analytical decision inputs are those analytes specified as the Segment 5 AoIs per Table 11-1, as sampled at the POEs for Stream Segment 5. RFCA provides specific criteria for regulated contaminants for the main stream channels of Segment 5. In developing the IMP, the DQOs identified a subset of contaminants that are of sufficient interest to warrant monitoring under ALF.

Segment 5 includes North and South Walnut Creek between the IA and the terminal ponds, and the SID between the IA and Pond C-2. Monitoring will be performed for Stream Segment 5 only as represented by POEs SW093, SW027, and GS10 (see Figure 2-1). The 995POE location, at the WWTP effluent, was dismantled on 11/18/04 (WY05). All WWTP data through 11/18/04 was included in the WY04 report to close out the location

Sampling for AoIs at POEs is performed by collecting continuous flow-paced composite samples. The recommended monitoring design specified in the IMP is to take samples for WY05 as specified in Table 11-5 and Table 11-6. The intent is to take no less than one sample per quarter and no more than four composite samples per month from each of the three monitoring locations.

Table 11-5 presents the approximate location-specific number of samples per month based on recommendations by statisticians at Pacific Northwest National Laboratory (PNNL) that worked with the DQO working group. There are both practical and statistical advantages to this sample allocation design. Averaging a larger number of samples is more expensive, but it protects the Site from regulatory action in response to a spurious, non-representative monitoring result.

There are secondary advantages to this monitoring plan. A larger number of samples allows for estimates of variability that can be used to refine the monitoring plan over time. The monitoring program specified in the IMP is a technically defensible approach that represents a compromise between a statistical design, a design based on professional judgment, and a design based on budgetary constraints. This design will generate data that are representative of contaminant levels and loads.

This design is consistent with the intent of the 30-day moving average specified in RFCA but allows some flexibility. Where there is no significant flow, there may be no samples completed within a 30-day period, and where the flows, loads, and variability are expected to be higher, sample numbers are also higher. Note that flow-paced monitoring will continue during dry periods, although flows may be so low that it takes more than 30 days to fill the composite sample container.

Indicator parameters are measured using real-time water-quality probes as discussed in Section 10 for the NSD monitoring objective. These data may be used in this decision rule for correlations and trending.

Table 11-1. RFCA Segment 5 AoIs.

Radionuclides:	Total Pu-239,240	Known carcinogen. Known past measurements (within the past 8 years) have exceeded RFCA Action Levels. This provides reasonable cause to expect future measurements in excess of RFCA Action Levels.
	Total U-233,234, U-235, U-238	Known renal toxicity. Present on Site. Past measurements provide reasonable cause to expect future measurements in excess of RFCA Action Levels.
	Total Am-241	Known carcinogen. Present on Site. Known past measurements have exceeded RFCA Action Levels. This provides reasonable cause to expect future measurements in excess of RFCA Action Levels.
Metals:	Total Be	Known to cause berylliosis in susceptible individuals when exposed by inhalation. May also cause contact dermatitis. Present on Site. Will be monitored as an indicator of releases from process and waste storage areas.
	Total Cr	Physiological and dermal toxicity. High level of regulatory concern due, in part to the chromic acid incident of 1989. Low levels can cause significant ecological damage.
	Dissolved Ag	Highly toxic to fish at low levels if chronic. State of Colorado has temporarily removed its stream standard for silver, while under study. The study has been completed, and the standard will be reinstated at the next triennial review of South Platte stream standards, if not before. Used on Site only for photographic development. Routinely accepted by POTWs as municipal waste, but discharge is regulated. May be removed from this list later, if data do not support concern.
	Dissolved Cd	Highly toxic to fish at low levels if chronic. Known human carcinogen (prostate cancer) and depletes physiologic calcium. Used on Site in plating processes. Monitoring data for the Interceptor Trench System (ITS) and the proposed discharge of untreated ITS waters into Walnut Creek provide reasonable cause to expect future releases in excess of RFCA Action Levels.
	Hardness	Required to evaluate metals analyses, due to its effect on solubility of these metals.
Real Time Monitoring of Physical and Indicator Parameters:	pH	Toxicity to humans and ecology. Regulatory concern due to chromic acid incident. Real-time monitoring is inexpensive and effective method of detecting acid spills such as (chromic acid or Pu nitrate) or failure of treatment systems.
These parameters provide real-time indicators for a wide variety of regulated contaminants, and are also a required component of monitoring for AoIs.	Conductivity	Conductivity is an indicator of total dissolved solids, metals, anions, and pH. Real-time monitoring of conductivity is an inexpensive indicator of overall water quality.
They require no laboratory analyses, and are the Site's most cost effective defensive monitoring.	Turbidity	Turbidity is a general indicator of elevated contaminant levels and may be correlated with Pu.
	Nitrate	Past releases near RFCA stream standards and action levels upstream of ponds provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels. ITS discharges are often high in nitrate and may challenge RFCA action levels.
	Flow	Required to detect flow events, pace automated samplers, evaluate contaminant loads, and plan pond operations and discharges. Affects nearly every decision rule, and is the most commonly discussed attribute of Site surface waters.

Notes: ITS = Interceptor Trench System; POTW = Publicly owned treatment works; VOA = Volatile organic analysis

11.2 WY05 MONITORING SCOPE

Table 11-2. POE Monitoring Locations.

Location Code	Location	Primary Flow Measurement Device	Telemetry
GS10	S. Walnut Cr. upstream from the B-1 Bypass	9" Parshall Flume	Yes
SW027	SID just upstream of Pond C-2	Dual Parallel 120° V-Notch Weirs	Yes
SW093	N. Walnut Cr. 1300' upstream from the A-1 Bypass	36" Suppressed Rectangular Sharp-Crested Weir; 3' H-Flume installed 5/29/03	Yes

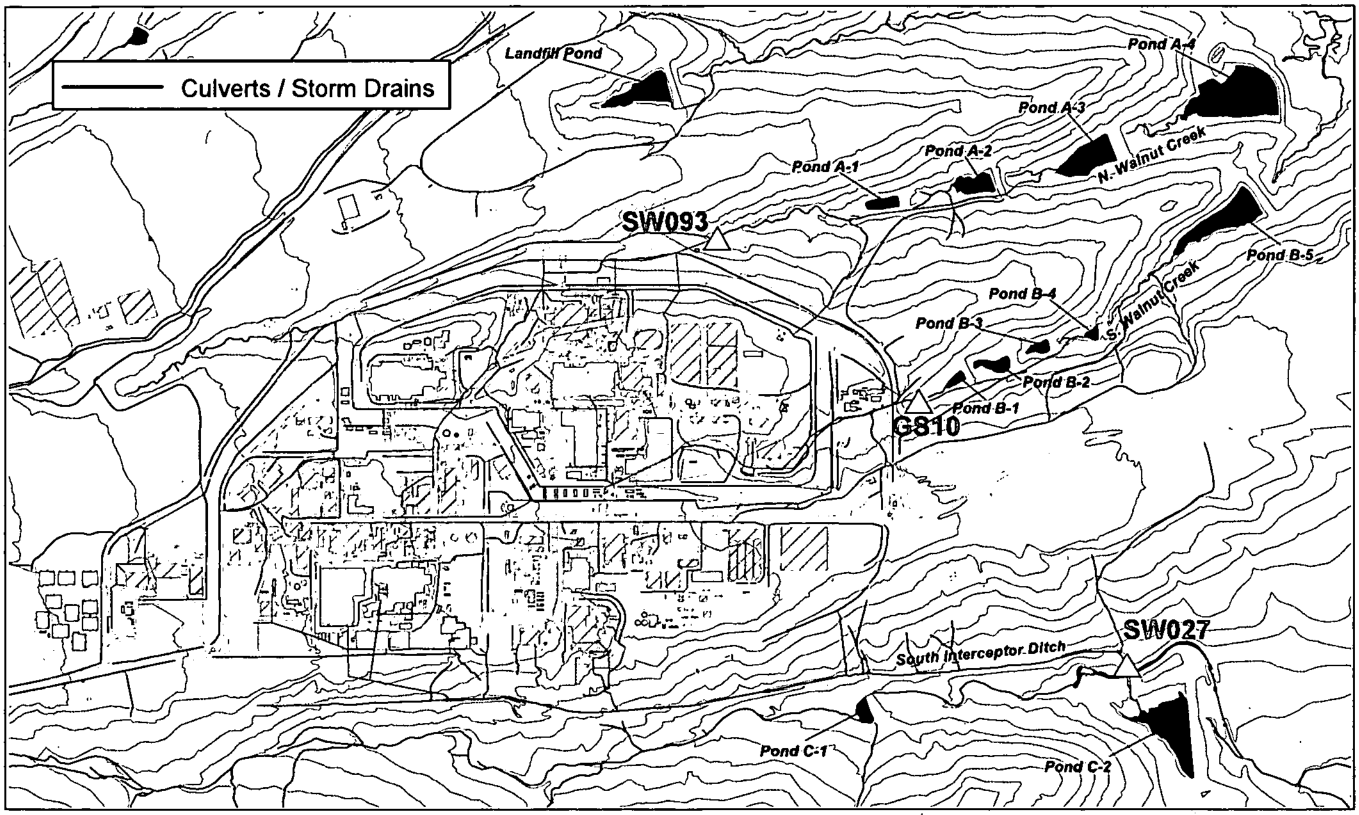


Figure 11-1. WY05 Point of Evaluation Monitoring Locations.

Table 11-3. POE Field Data Collection: Parameters and Frequency.

Location Code	Parameter: Discharge	Parameter: Real-Time pH, Conductivity, Turbidity, Nitrate
GS10	15-min continuous	15-min continuous
SW027	15-min continuous	15-min continuous
SW093	15-min continuous	15-min continuous

Note: All locations collect 5- and 15-minute flow data.

Table 11-4. POE Sample Collection Protocols.

Location Code	Frequency[a]: WY05 Actual (Target)	Type[b]
GS10	28 (34 per year)	Continuous flow-paced composites
SW027[48]	8 (17 per year)	Continuous flow-paced composites
SW093	27 (36 per year)	Continuous flow-paced composites

Notes: [a] Sample frequency distribution during the year for SW093, GS10, and SW027 (POEs) is given in Table 11-5.
[b] Sample types are defined in Appendix B.

Table 11-5. POE Target Sample Distribution.

Month	SW093: WY05 Actual (Target)	GS10: WY05 Actual (Target)	SW027: WY05 Actual (Target)	Totals: WY05 Actual (Target)
Oct 04	3 (2)	3 (2)	2 (0)	8 (4)
Nov 04	2 (3)	2 (2)	0 (1)	4 (6)
Dec 04	2 (2)	3 (2)	0 (0)	5 (4)
Jan 05	2 (2)	1 (2)	0 (0)	3 (4)
Feb 05	2 (2)	2 (2)	0 (0)	4 (4)
Mar 05	2 (4)	1 (4)	0 (3)	3 (11)
Apr 05	5 (4)	4 (4)	4 (4)	13 (12)
May 05	2 (4)	2 (4)	2 (4)	6 (12)
Jun 05	4 (4)	4 (3)	0 (2)	8 (9)
Jul 05	0 (3)	2 (3)	0 (1)	2 (7)
Aug 05	1 (3)	2 (3)	0 (1)	3 (7)
Sep 05	2 (3)	2 (3)	0 (1)	4 (7)
Totals	**27 (36)**	**28 (34)**	**8 (17)**	**63 (87)**

Table 11-6. POE Analytical Targets (Analyses per Year).

Location Code	Dissolved Ag, Total Be, Dissolved Cd, Total Cr WY05 Actual (Target)	Hardness WY05 Actual (Target)	Pu, U, and Am WY05 Actual (Target)
GS10	28 (34)	28 (34)	28 (34)
SW027	8 (17)	8 (17)	8 (17)
SW093	27 (36)	27 (36)	27 (36)

11.3 DATA EVALUATION

Sampling for AoIs at POEs is performed by collecting continuous flow-paced composite samples. Indicator parameters are measured using real-time water-quality probes. The AoIs are evaluated using 30-day moving averages, as specified in RFCA and implemented by the ALF or DQOs. Total Pu, Am, U, Be, and Cr, and dissolved Ag and Cd are evaluated using volume-weighted 30-day moving averages at POEs[49]. Indicator parameters are evaluated qualitatively to assess chronic trends and annual variability.

[48] As of the publication of this report, the composite sample at SW027 started on 5/18/05 was still in progress. SW027 has not flowed since 6/14/05 and the composite currently contains 2.2 liters, a non-sufficient quantity for analysis. Therefore, the analytical results for this sample are not included in this section.

[49] The 30-day average for a particular day is calculated as a volume-weighted average of a 'window' of time containing the previous 30-days which had flow. Each day has its own discharge volume (measured at the location with a flow meter) and activity (analytical result from the sample in place at the end of that day). Therefore, there are 365 30-day moving average values for a location that flows all year (366 values in a leap year). At locations which monitor pond discharges or have intermittent flows, 30-day averages are reported as averages of the previous 30 days of greater than zero flow. For days where no activity or flow is available, no 30-day average is reported. The calculation of 30-day averages is discussed in detail in Appendix B1: Data Evaluation Methods.

The parties to RFCA agree that continuous monitoring probes will be used as indicators that may suggest a need for additional monitoring, mitigating action, or management decision. The parties agree that compliance and enforcement issues will be resolved based on standard analytical procedures required by the applicable agreement or regulations (e.g., RFCA or CERCLA). The parties agree that continuous monitoring field probes should NOT be used to determine compliance or serve as a basis for enforcement action, unless the applicable regulation specifies such a probe as the enforceable analytical method for a particular measurement.

Generally, analytical data evaluation is performed as preliminary data become available. If an initial qualitative screening indicates that an analytical result is higher than the action level for a particular AoI, then the 30-day average is calculated immediately upon receipt of the preliminary result. The desired evaluation frequency is semi-monthly, within one week of the 15th and last day of any given month. The DQO decision rule is:

IF — The appropriate summary statistic for any AoI in the main stream channels of Stream Segment 5, as monitored at the designated POEs, exceeds the appropriate RFCA action level[50] (Table 11-8)

THEN — The Site must notify EPA and CDPHE, evaluate for source location, and implement mitigating action[51] if appropriate[52].

Table 11-7. POE Monitoring Analytical Data Evaluation.

Location Code	Evaluation Type[a]
GS10	30-Day Volume-Weighted Moving Averages; Loading Analysis
SW027	30-Day Volume-Weighted Moving Averages; Loading Analysis
SW093	30-Day Volume-Weighted Moving Averages; Loading Analysis

Notes: [a] Details on the evaluation of analytical results are given in Appendix B.1: Data Evaluation Methods. Loading analysis for POEs is given in Section 5.

Table 11-8. POE Monitoring RFCA Action Levels.

Analyte	Action Level
Am-241	0.15 pCi/L
Pu-239,240	0.15 pCi/L
Total Uranium	10 pCi/L (GS10 and SW093); 11 pCi/L (SW027)
Total Be	4 μg/L
Dissolved Cd	1.5 μg/L
Total Cr	50 μg/L
Dissolved Ag	0.6 μg/L

Note: The above action levels only apply to 30-day average values. Comparisons to other values are provided for reference only.

The following sections include summary tables and plots showing the 30-day volume-weighted averages, periodic volume-weighted averages, and volume-weighted 12-month rolling averages[53] for the POE analytes. Prior to

[50] Appropriate action levels and standards for volume-weighted 30-day moving averages are specified for individual contaminants in RFCA.

[51] Mitigating action may include, but not be limited to, the following examples: 1) Immediate action to halt a discharge or contain a spill; or 2) Use of the Source Location decision rule to seek out and mitigate upstream contaminant sources.

[52] EPA determines the consequences for an exceedance of any action level (not just those for AoIs) at any location within the segment (not just at the consensus monitoring points). This decision rule presents the consensus decision rule that drives our monitoring activities. It is an implementation, rather than a reiteration, of RFCA.

[53] The 12-month rolling average for the last day of a particular month is calculated as a volume-weighted average of a "window" of time containing the previous 12 months. Each 12-month 'window' includes daily discharge volumes (measured at the location with a flow meter) and daily activities (from the sample carboy in place at the end of that day). Therefore, there are twelve 12-month rolling averages for a given calendar year. Days with no flow or no analytical result, either due to failed laboratory analysis or NSQ for analysis, are not included in the average. When no flow has occurred in the last 12 months, no 12-month rolling average is reported.

1/1/00, the action levels for both dissolved Cd and Ag were calculated to take into account the toxicity of these metals in relation to hardness. The action levels were calculated for each day using the corresponding 30-day volume-weighted hardness values. Therefore, the action levels vary with varying hardness. Starting on 1/1/00, in consultation with the Regulators and Stakeholders, the action levels used for these metals assumes a fixed hardness of 143 mg/L, which is consistent with State water-quality standard methodology.

The following evaluations include all results that were not rejected through the verification and validation process. Data are generally presented to decimal places as reported by the laboratories. Accuracy should not be inferred; minimum detectable concentrations/activities and analytical error are often greater than the precision presented. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the 'real' and the 'duplicate' values. When a sample has multiple 'real' analyses (Site requested 'reruns'), the value used in calculations is the arithmetic average of the multiple 'real' analyses. Total uranium is calculated by summing the activities for the analyzed isotopes (U-233,234 + U-235 + U-238).

The methods used for the evaluations are given in Appendix B.1: Data Evaluation Methods.

The loading analysis for GS10, SW027, and SW093 is presented in Section 5.

Real-time water quality data are not presented in this section. Plots of mean daily water temperature, specific conductivity, pH, and turbidity values are given in Section 10. More detailed data for all parameters are presented in Appendix B.5.2. The methods used for the water-quality parameter evaluations are given in Appendix B.5: Real-Time Water-Quality Parameters.

11.3.1 Location GS10

Monitoring location GS10 is located on South Walnut Creek at the perimeter of the IA just upstream of the B-Series Ponds. Figure 3-31 shows the drainage area for GS10. The 100, 300, 400, 500, 600, 700, 800, and 900 areas all contribute flow to GS10.

Table 11-9 shows that a majority of the annual average Pu and Am activities were greater than 0.15 pCi/L, with measurable increases in WY04-05. Source evaluation for POE GS10 identified runoff from the 903 Pad area as the primary contributor of Pu and Am load in WY04. Source evaluation in WY05 for POE GS10 identified solids transport resulting from the construction of Functional Channel #4 and Closure actions in the 700 Area as the primary contributor of Pu and Am load in WY05. With the completion of the functional channels, implementation of enhanced erosion controls, revegetation, and soil stabilization, transport of Pu and Am approaching the action level has been virtually eliminated.

Figure 11-2 shows multiple occurrences of reportable 30-day averages for Pu and Am. In response, the Site was required to perform source evaluations to address these reportable values as discussed above. A summary of the source evaluation investigations is given in Section 6.3.2.

Figure 11-3 shows that the 30-day averages for total uranium required reporting during WY05, with a noticeable upward trend. Source evaluation at GS10 identified hydrologic changes at GS10 as the cause of the increases in total uranium. As impervious areas were removed at the Site (reducing direct runoff during precipitation events), groundwater contributions to the creek with naturally occurring uranium represented a larger portion of the streamflow monitored at GS10. Without direct runoff contributions to mix with the groundwater uranium contributions, samples from GS10 began to reflect the naturally occurring groundwater uranium concentrations (often significantly greater than the surface-water action level).

Since 1999, RFETS groundwater and surface water samples from select locations have been sent to Los Alamos National Laboratory for high resolution inductively coupled mass spectrometry (HR ICP/MS) and/or thermal ionization mass spectrometry (TIMS) analyses. These analyses measure mass ratios of four uranium isotopes (masses 234, 235, 236, and 238) and are detailed in the reports titled "Uranium in Surface Soil, Surface Water, and Groundwater at the Rocky Flats Environmental Technology Site, dated June 2004" and in the "Interim Measure/Interim Remedial Action for Groundwater at the Rocky Flats Environmental Technology Site, dated June 21, 2005". Isotopic ratios provide a signature that indicates whether the source of uranium is natural or anthropogenic (man-made). The results to date indicate that all the groundwater and surface-water locations at the Site display a predominately natural signature.

Table 11-9. Annual Volume-Weighted Average Radionuclide Activities at GS10 in WY97-05.

Water Year	Volume-Weighted Average Activity (pCi/L)		
	Am-241	***Pu-239,240***	***Total Uranium***
1997	0.302	0.295	2.85
1998	0.105	0.152	2.99
1999	0.276	0.140	2.48
2000	0.397	0.185	2.19
2001	0.072	0.078	2.84
2002	0.083	0.053	3.04
2003	0.114	0.113	2.69
2004	0.148	0.362	2.43
2005	0.166	0.197	6.45
Total (WY97-05)	0.192	0.176	3.00

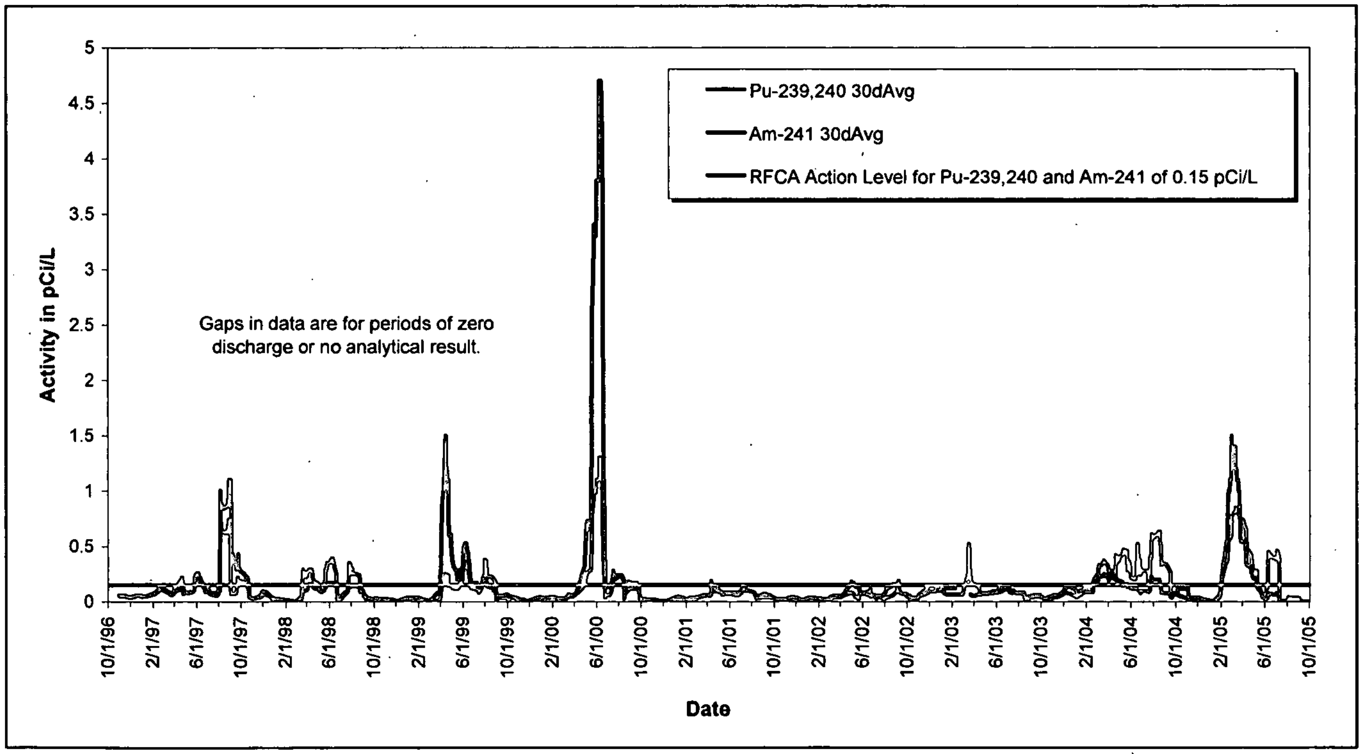


Figure 11-2. Volume-Weighted 30-Day Average Pu and Am Activities at GS10: WY97–05.

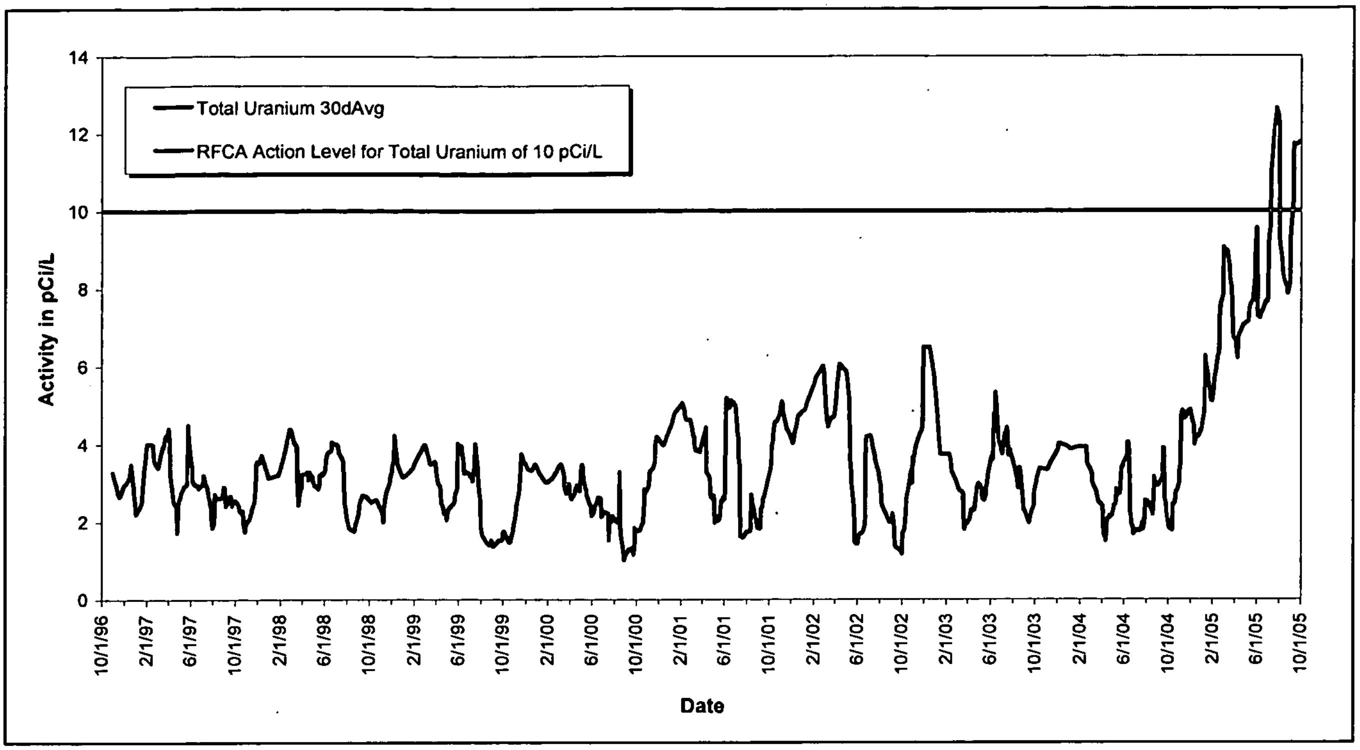


Figure 11-3. Volume-Weighted 30-Day Average Total Uranium Activities at GS10: WY97–05.

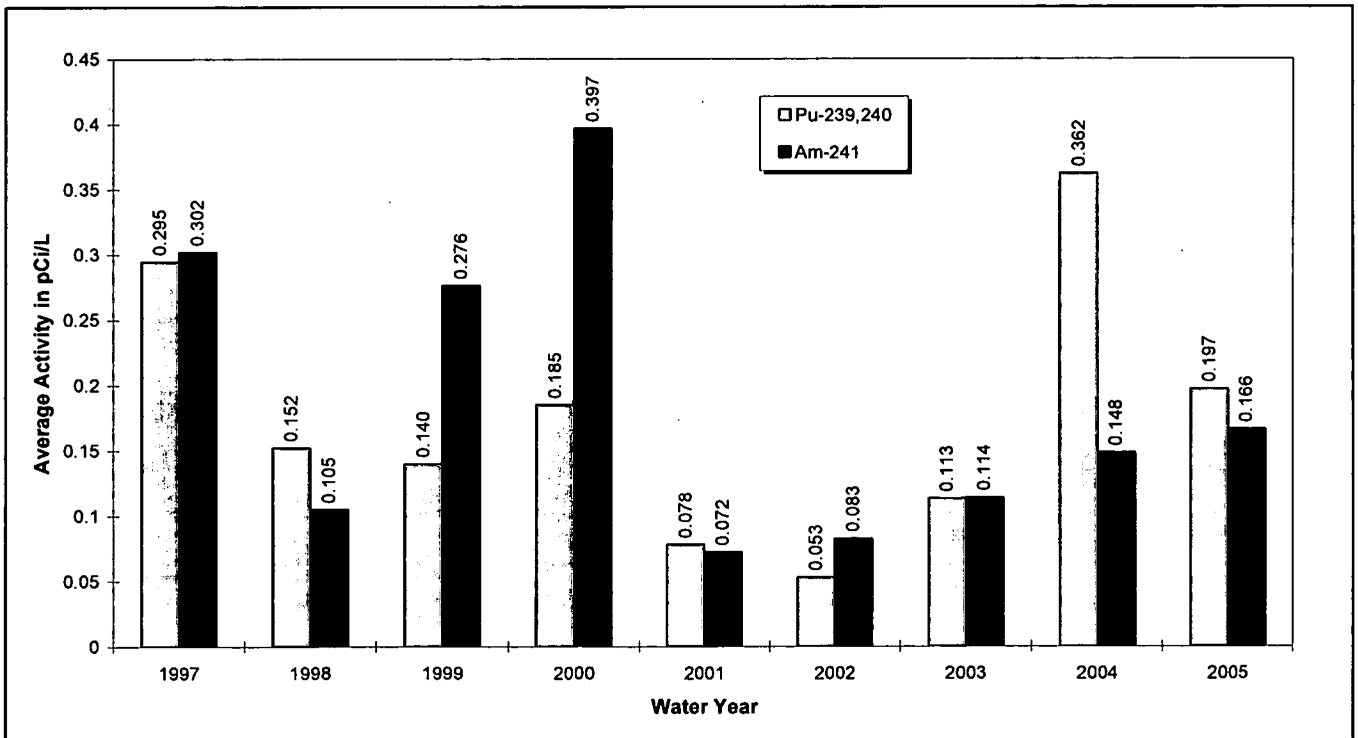


Figure 11-4. Annual Volume-Weighted Average Pu and Am Activities at GS10: WY97–05.

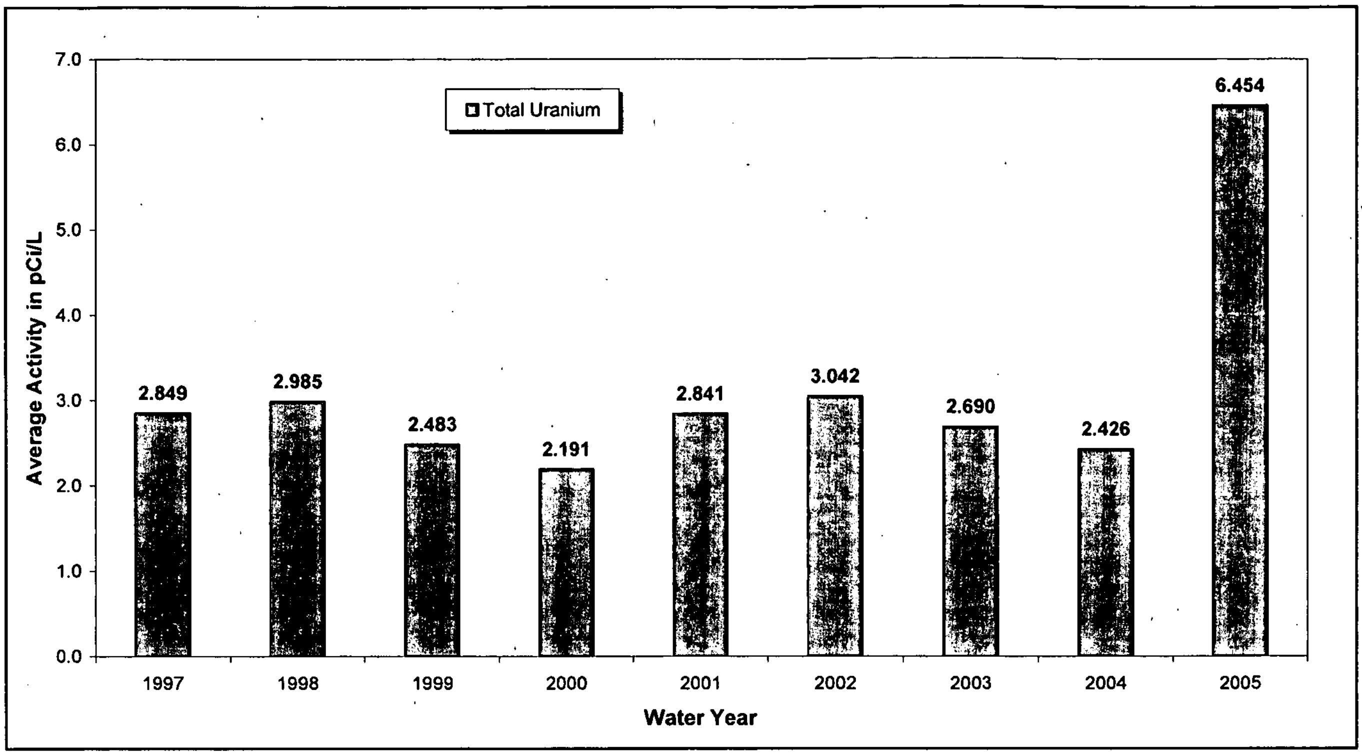


Figure 11-5. Annual Volume-Weighted Average Total Uranium Activities at GS10: WY97–05.

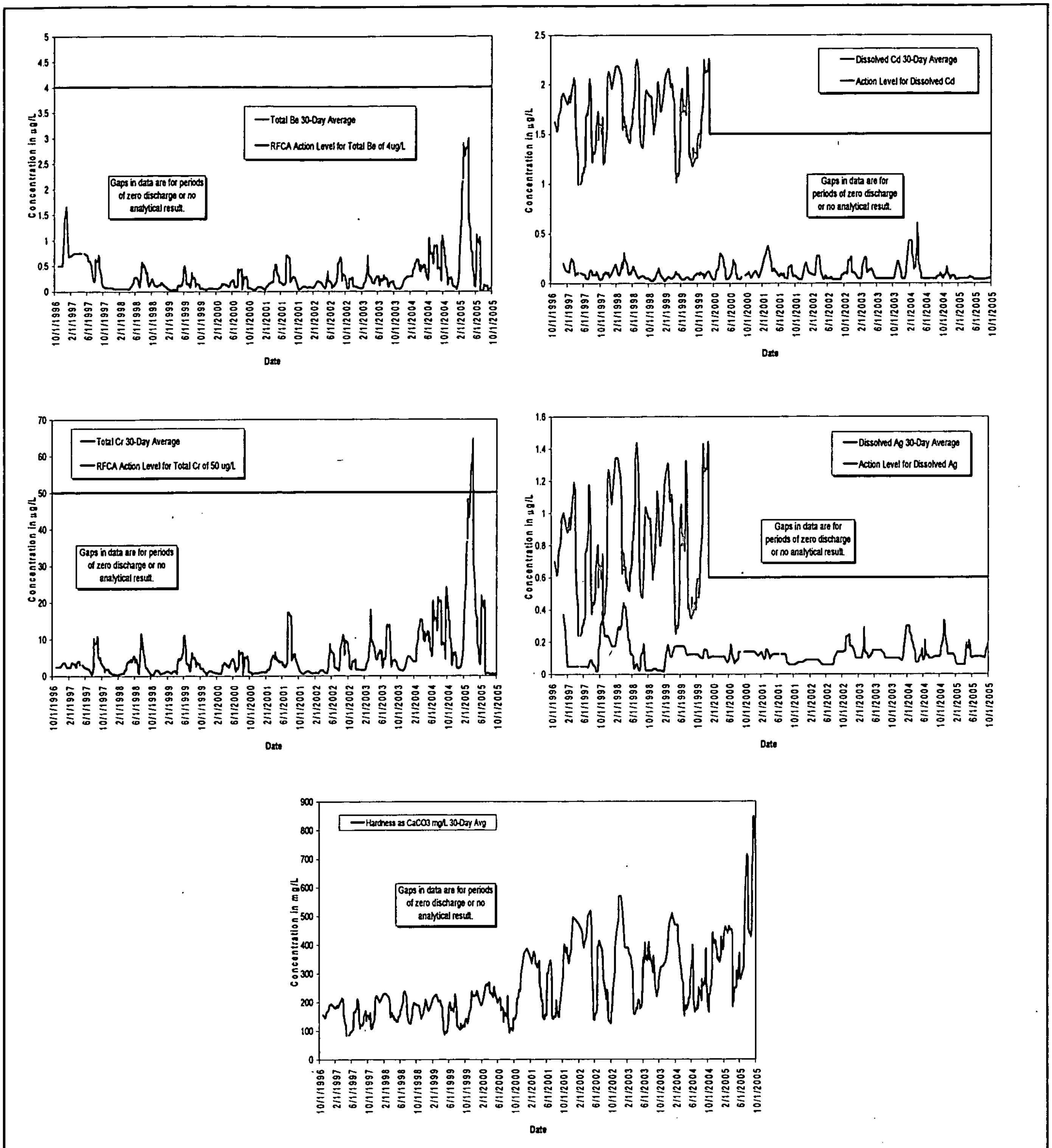
Table 11-10 shows that all of the annual average metals concentrations were less than the action level. Additionally, the long-term metals averages (WY97-05) were less than the action levels.

Figure 11-6 shows that none of the 30-day averages were reportable for Be, Cd, or Ag. Chromium shows a short-term reportable period in March-April 2005. A source evaluation was performed (see Section 6.3.2) concluding that increased transport of suspended solids was the cause. The increases in the 30-day average hardness values is likely the result of winter deicing operations and the WY00 change to new deicing products (magnesium chloride). Hardness levels have increased as a result of these changes.

Table 11-10. Annual Volume-Weighted Average Hardness and Metals Concentrations at GS10 in WY97-05.

Water Year	Volume-Weighted Average Concentration (µg/L)				
	Hardness [mg/L]	Total Be	Dissolved Cd	Total Cr	Dissolved Ag
1997	137	0.64	0.09	4.62	0.08
1998	159	0.14	0.13	3.19	0.24
1999	134	0.17	0.07	4.09	0.13
2000	173	0.20	0.11	3.53	0.11
2001	213	0.32	0.11	5.82	0.12
2002	283	0.24	0.08	5.10	0.08
2003	229	0.22	0.11	6.80	0.13
2004	232	0.61	0.11	13.4	0.12
2005	347	0.79	0.06	16.3	0.15
Total (WY97-05)	199	0.35	0.10	6.43	0.13

Note: Hardness units mg/L.



Note: Prior to 1/1/00, action levels for dissolved Cd and Ag were calculated using the analyte specific toxicity equation incorporating the 30-day volume-weighted hardness values.

Figure 11-6. Volume-Weighted 30-Day Average Metals and Hardness Concentrations at GS10: WY97–05.

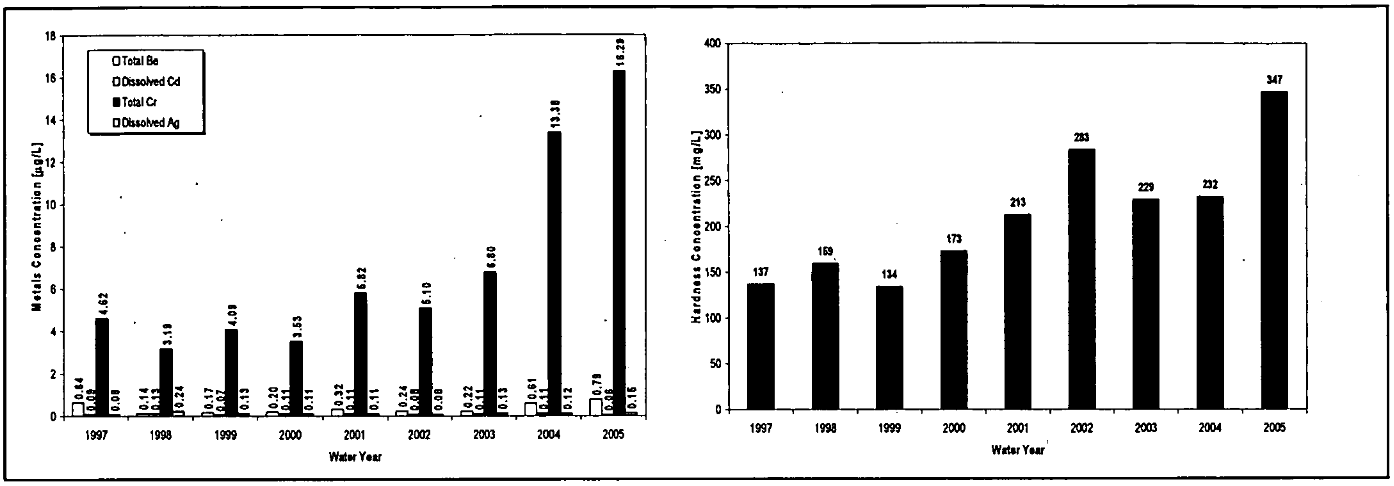
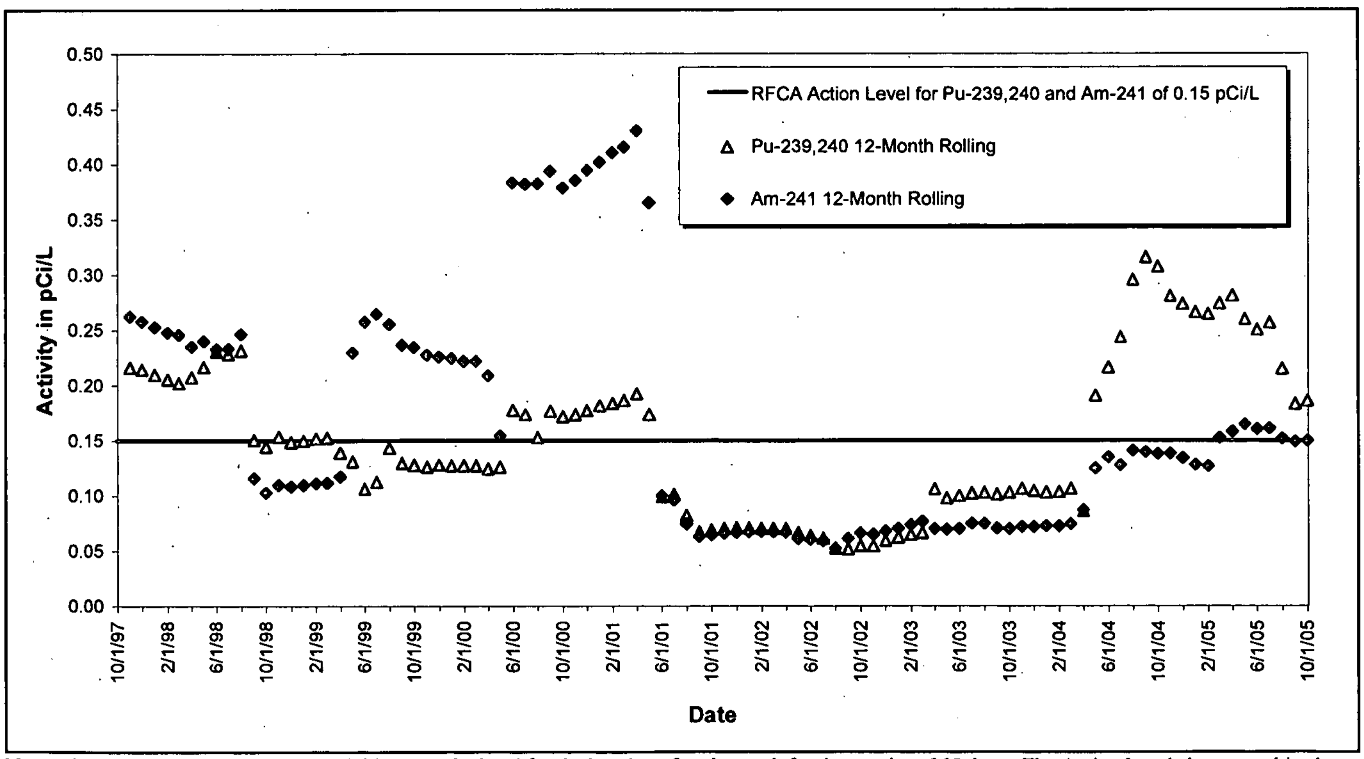
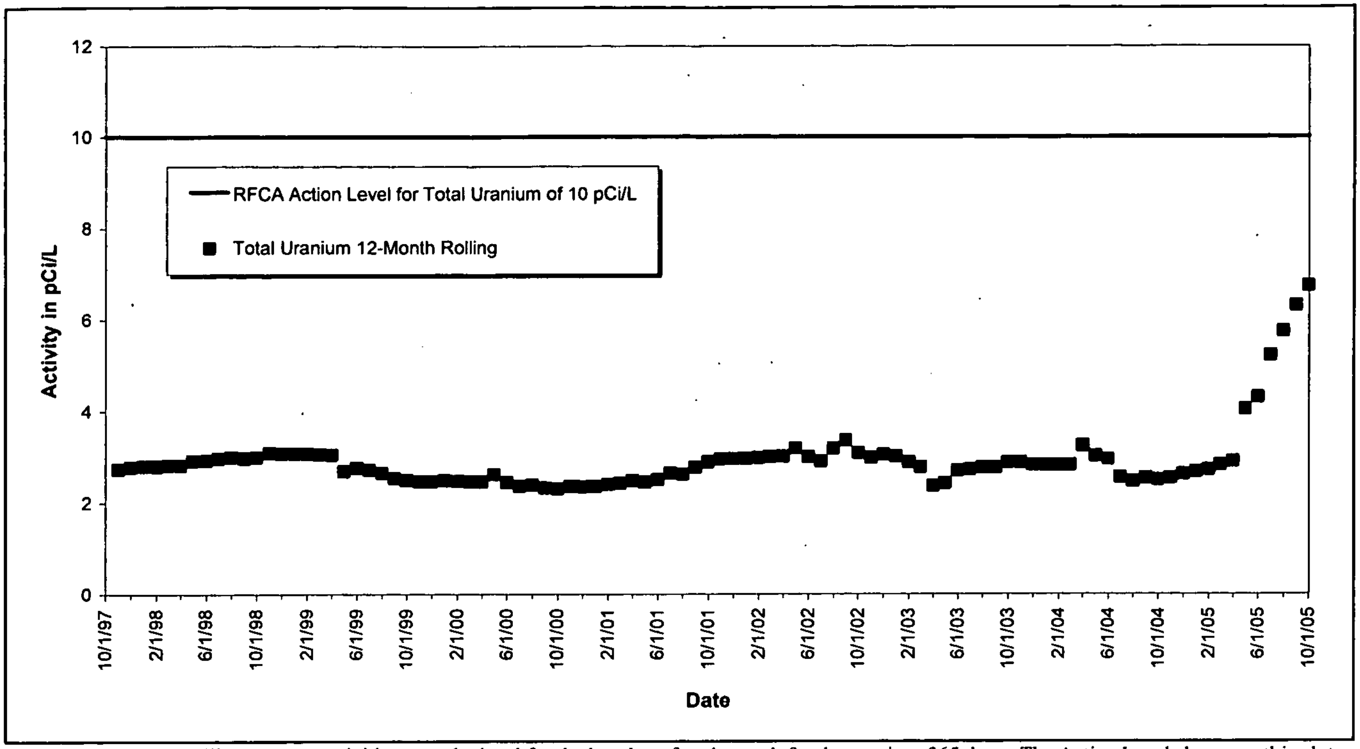


Figure 11-7. Annual Volume-Weighted Average Metals and Hardness Concentrations at GS10: WY97–05.



Note: The 12-month rolling average activities are calculated for the last day of each month for the previous 365 days. The Action Level shown on this plot only applies to 30-day averages. It is shown here for reference only.

Figure 11-8. Volume-Weighted 12-Month Rolling Average Pu and Am Activities at GS10: WY98-05.



Note: The 12-month rolling average activities are calculated for the last day of each month for the previous 365 days. The Action Level shown on this plot only applies to 30-day averages. It is shown here for reference only.

Figure 11-9. Volume-Weighted 12-Month Rolling Average Total Uranium Activities at GS10: WY98-05.

11.3.2 Location SW027

Monitoring location SW027 is located at the end of the SID at the inlet to Pond C-2. Figure 3-116 shows the drainage area for SW027. The 100, 400, 600, 800, and 900 areas all contribute flow to SW027.

Table 11-11 shows that the majority of the annual average Pu and Am activities were less than 0.15 pCi/L.[54] The increased WY00 Pu activity was the result of a single sample (5/11-7/17/00, 1.03 pCi/L). The significant increase in WY04 was the result of increased solids transport from disturbed areas associated with the 903 Pad/Lip accelerated actions. In response, the Site aggressively enhanced the pre-existing erosion control program to further reduce the transport of suspended solids from disturbed areas. With the completion of the 903 Pad/Lip actions, implementation of enhanced erosion controls, revegetation, and soil stabilization, transport of Pu and Am approaching the action level has been virtually eliminated. The total uranium average activities are well below 11 pCi/L.

Figure 11-10 shows several periods of reportable 30-day averages for Pu and Am. In response, the Site was required to perform source evaluations to address these reportable values. A summary of the source evaluation investigations is given in Section 6.3.4.

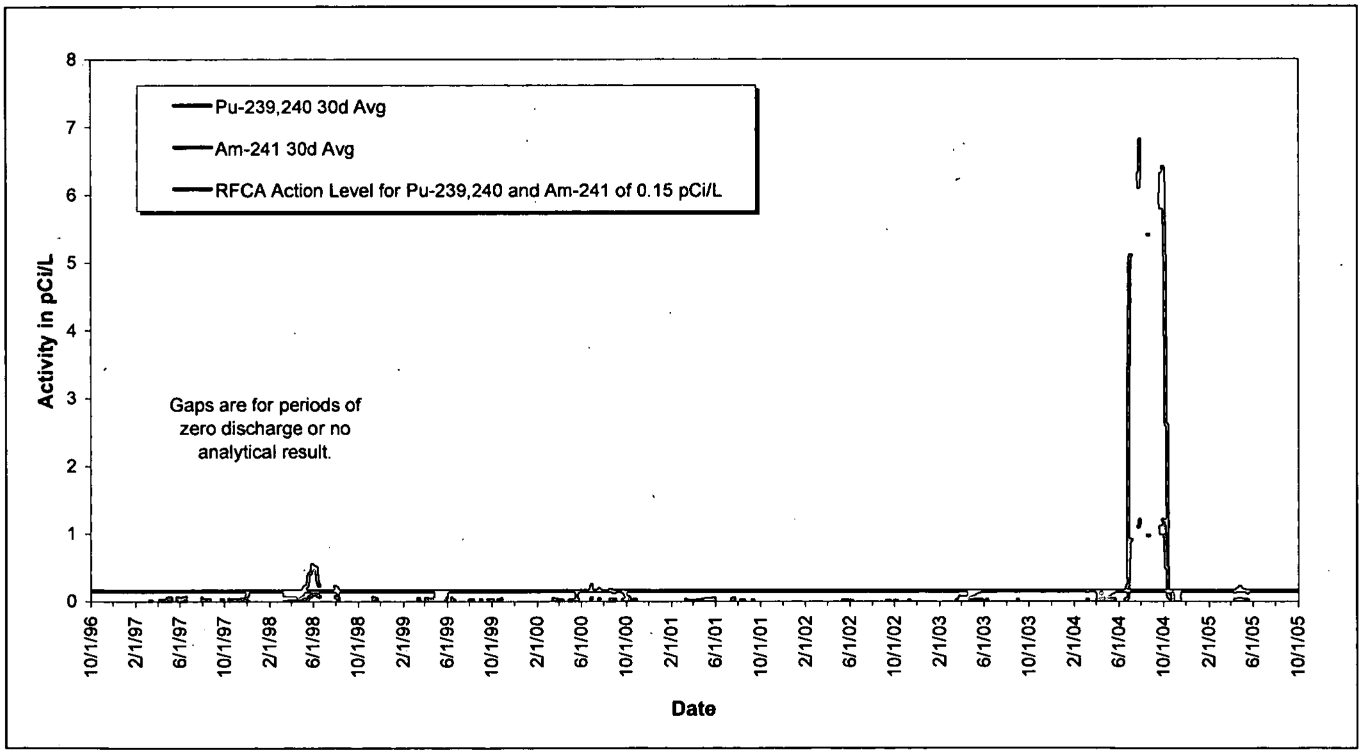
Figure 11-11 shows that the 30-day average for total uranium was below action levels for the entire period.

[54] As of the publication of this report, the composite sample at SW027 started on 5/18/05 was still in progress. SW027 has not flowed since 6/14/05 and the composite currently contains 2.2 liters, a non-sufficient quantity for analysis. Therefore, the analytical results for this sample are not included in this section.

Table 11-11. Annual Volume-Weighted Average Radionuclide Activities at SW027 in WY97-05.

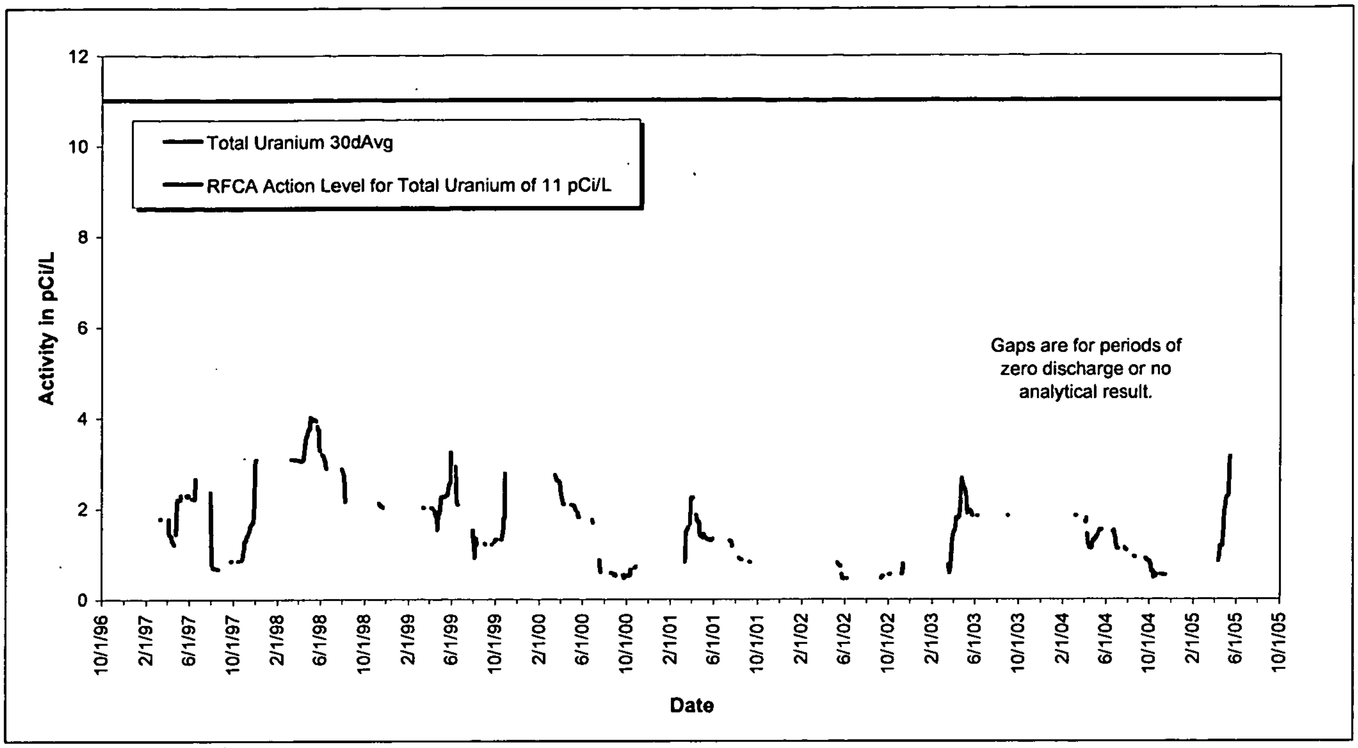
Water Year	Volume-Weighted Average Activity (pCi/L)		
	Am-241	*Pu-239,240*	*Total Uranium*
1997	0.007	0.037	1.43
1998	0.021	0.140	3.21
1999	0.018	0.067	1.87
2000	0.059	0.327	1.21
2001	0.006	0.025	1.33
2002	0.001	0.002	0.497
2003	0.010	0.079	1.68
2004	0.478	2.67	1.14
2005	0.032	0.136	1.78
Total (WY97-05)	0.059	0.330	1.82

Note: Data through 5/17/05.



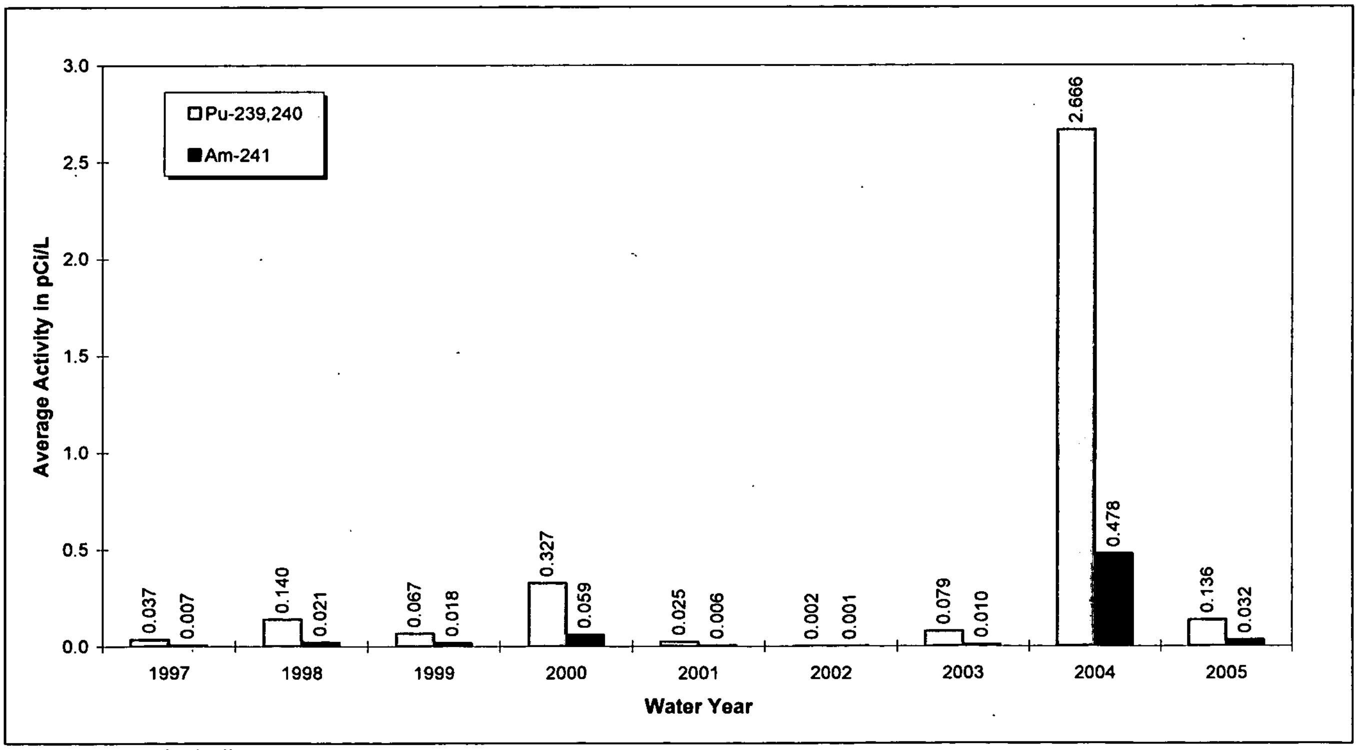
Note: Data through 5/17/05.

Figure 11-10. Volume-Weighted 30-Day Average Pu and Am Activities at SW027: WY97–05.



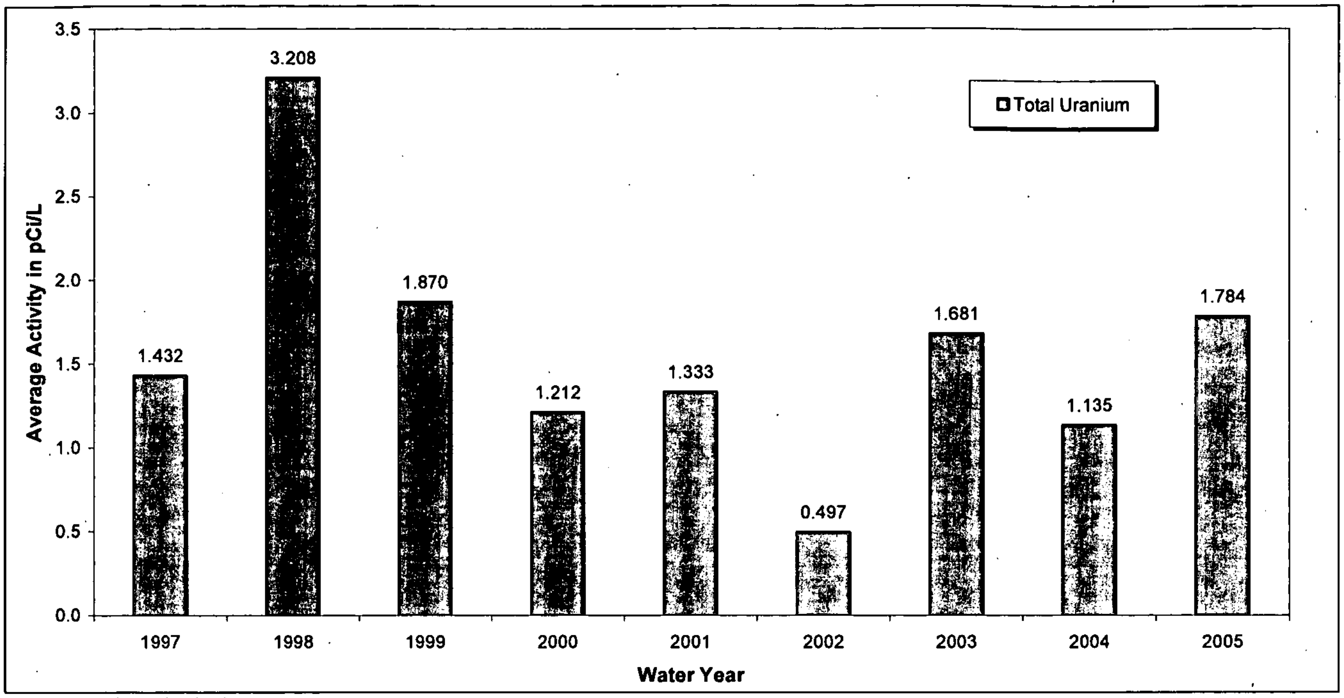
Note: Data through 5/17/05.

Figure 11-11. Volume-Weighted 30-Day Average Total Uranium Activities at SW027: WY97–05.



Note: Data through 5/17/05.

Figure 11-12. Annual Volume-Weighted Average Pu and Am Activities at SW027: WY97–05.



Note: Data through 5/17/05.

Figure 11-13. Annual Volume-Weighted Average Total Uranium Activities at SW027: WY97–05.

Table 11-12 shows that all of the annual average metals concentrations were less than the action level. Additionally, the long-term metals averages (WY97-05) were less than the action levels.

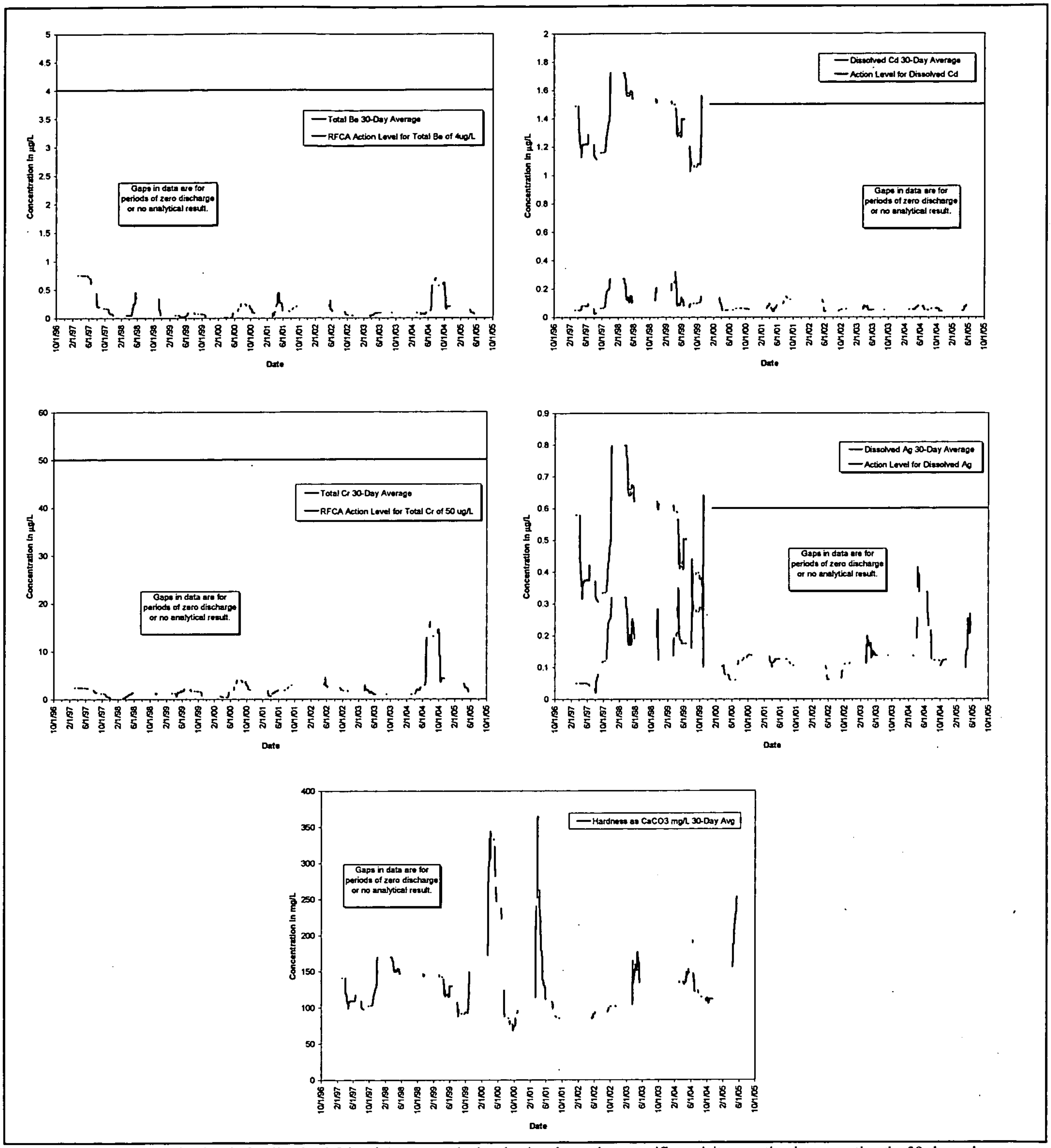
Figure 11-14 shows that none of the 30-day averages were reportable for Be, Cr, and Cd.[55] For dissolved Ag, the 30-day average was above the hardness-adjusted action level during WY99-00. However, using the agreed upon fixed hardness of 143 mg/L noted above, these values were not reportable. The recent increases in the 30-day average hardness values is likely the result of winter deicing operations and the WY00 change to new deicing products.

Table 11-12. Annual Volume-Weighted Average Hardness and Metals Concentrations at SW027 in WY97-05.

	Volume-Weighted Average Concentration (µg/L)				
Water Year	Hardness[mg/L]	Total Be	Dissolved Cd	Total Cr	Dissolved Ag
1997	103	0.53	0.06	2.01	0.06
1998	149	0.13	0.15	0.85	0.21
1999	109	0.03	0.10	1.56	0.25
2000	148	0.26	0.06	3.92	0.09
2001	147	0.23	0.07	1.81	0.12
2002	112	0.13	0.05	3.04	0.09
2003	148	0.06	0.06	1.75	0.15
2004	136	0.32	0.06	7.36	0.20
2005	193	0.16	0.06	3.80	0.17
Total (WY97-05)	137	0.19	0.09	2.38	0.16

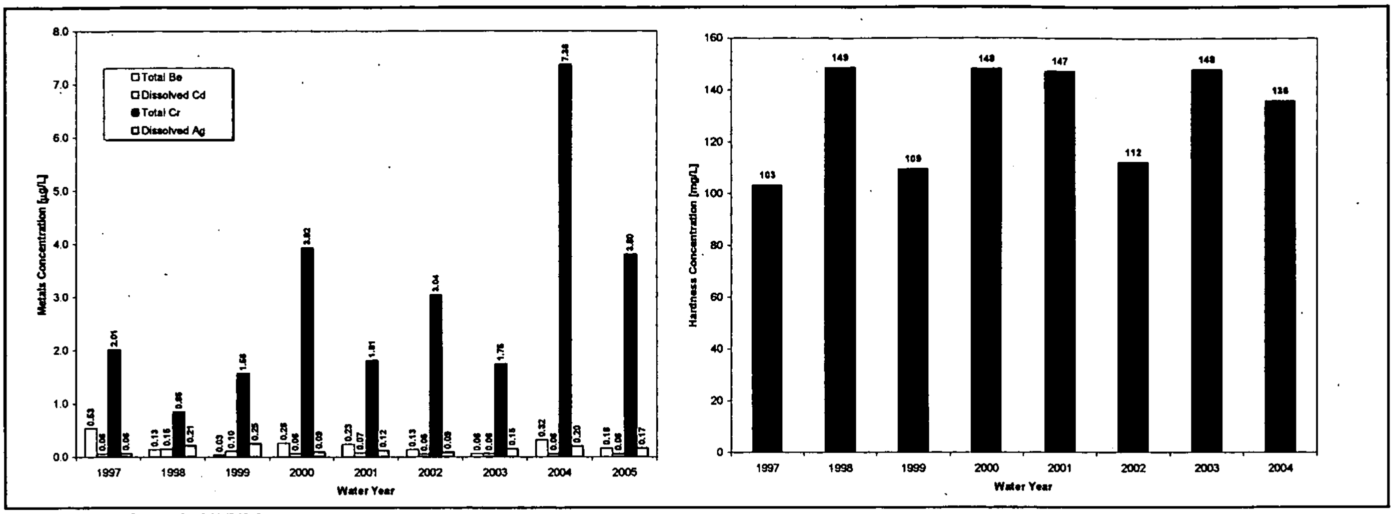
Note: Hardness units mg/L. Data through 5/17/05.

[55] Two dissolved Ag results collected in WY04 at SW027 did not meet the RPD criteria of <100% (see Appendix B.1: Data Evaluation Methods). As such, these dissolved Ag samples were not used in the calculation of the dissolved Ag 30-day averages for SW027. The initial results were 1.6 and 1.0 µg/L, and the duplicate results were both 0.2 µg/L (undetect; half the detect limit was used to calculate the RPD: 0.1 µg/L), for RPDs of 176.5% and 163.6%, respectively. The average of these results is used in all other evaluations.



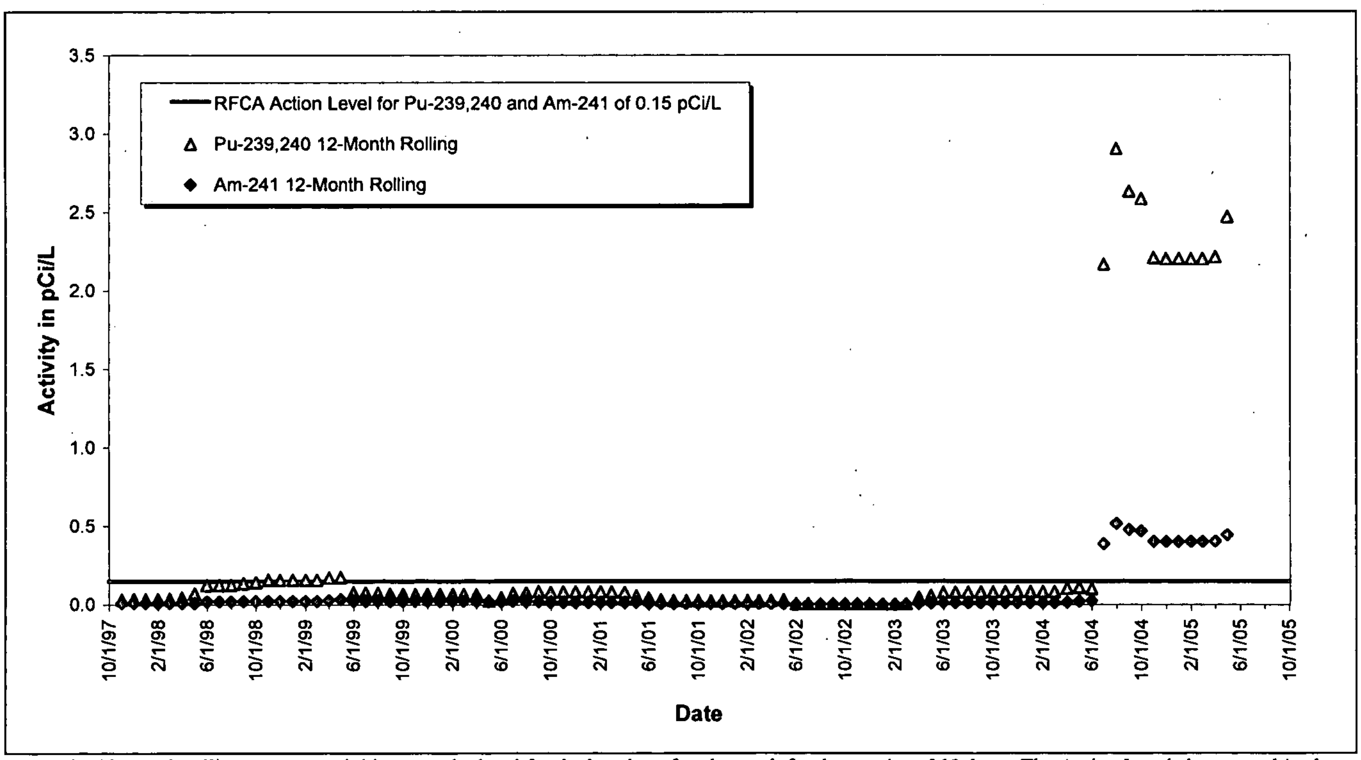
Note: Prior to 1/1/00, action levels for dissolved Cd and Ag were calculated using the analyte specific toxicity equation incorporating the 30-day volume-weighted hardness values. Data through 5/17/05.

Figure 11-14. Volume-Weighted 30-Day Average Metals and Hardness Concentrations at SW027: WY97–05.



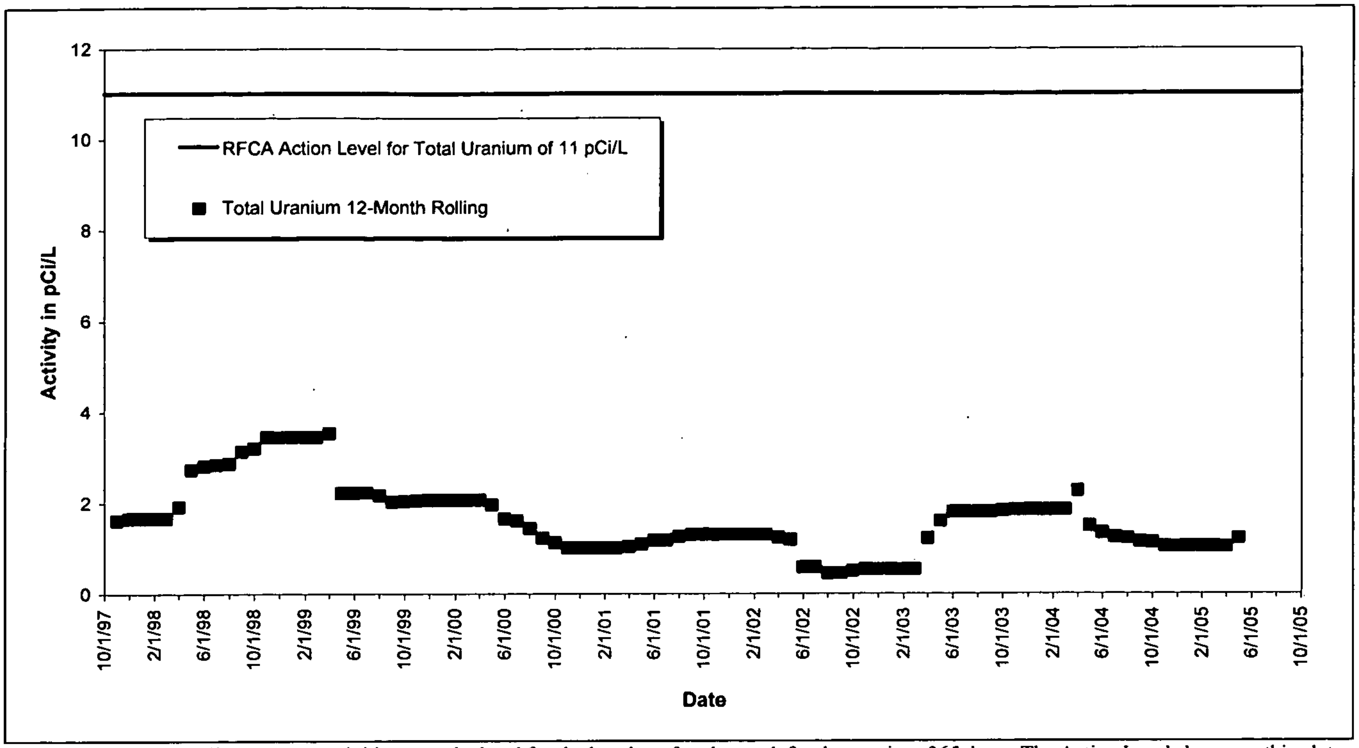
Note: Data through 5/17/05.

Figure 11-15. Annual Volume-Weighted Average Metals and Hardness Concentrations at SW027: WY97–05.



Note: The 12-month rolling average activities are calculated for the last day of each month for the previous 365 days. The Action Level shown on this plot only applies to 30-day averages. It is shown here for reference only. Data through 5/17/05.

Figure 11-16. Volume-Weighted 12-Month Rolling Average Pu and Am Activities at SW027: WY98-05.



Note: The 12-month rolling average activities are calculated for the last day of each month for the previous 365 days. The Action Level shown on this plot only applies to 30-day averages. It is shown here for reference only. Data through 5/17/05.

Figure 11-17. Volume-Weighted 12-Month Rolling Average Total Uranium Activities at SW027: WY98-05.

11.3.3 Location SW093

Monitoring location SW093 is located on North Walnut Creek at the perimeter of the IA 1300 feet upstream of the A-Series Ponds. Figure 3-125 shows the drainage area for SW093. The 100, 300, 500, 700, and 900 areas all contribute flow to SW093.

Table 11-13 shows a significant increase in Pu activities during WY04 and Am activities in WY04-05. The Pu increase in WY04 was attributed to increased solids transport from disturbed areas, especially the B779 area. In response, the Site aggressively enhanced the pre-existing erosion control program to further reduce the transport of suspended solids from disturbed areas. The Am increase in WY04-05 was attributed to dust suppression water flows from the former B771 footing drain. In response, the Site disrupted the drain and eliminated the pathway in December 2004. The cause of the WY05 reportable Pu values was the construction of Functional Channels #2/3 resulting in temporarily increased solids transport. With the completion of the functional channels, elimination of the B771 pathway, implementation of enhanced erosion controls, revegetation, and soil stabilization, transport of Pu and Am approaching the action level has been virtually eliminated. The total uranium average activities are below the 10 pCi/L action level.

Figure 11-18 shows several periods of reportable 30-day averages for Pu and Am. In response, the Site was required to perform source evaluations to address these reportable values. A summary of the source evaluation investigations is given in Section 6.3.3.

Figure 11-19 shows that the 30-day average for total uranium was below action levels for the entire period.

Table 11-13. Annual Volume-Weighted Average Radionuclide Activities at SW093 in WY97-05.

Water Year	Volume-Weighted Average Activity (pCi/L)		
	Am-241	*Pu-239,240*	*Total Uranium*
1997	0.045	0.073	2.76
1998	0.018	0.019	2.12
1999	0.025	0.039	1.94
2000	0.022	0.038	2.14
2001	0.011	0.015	2.09
2002	0.017	0.007	2.76
2003	0.036	0.050	2.43
2004	0.367	0.689	2.27
2005	0.445	0.037	3.44
Total (WY97-05)	0.084	0.090	2.35

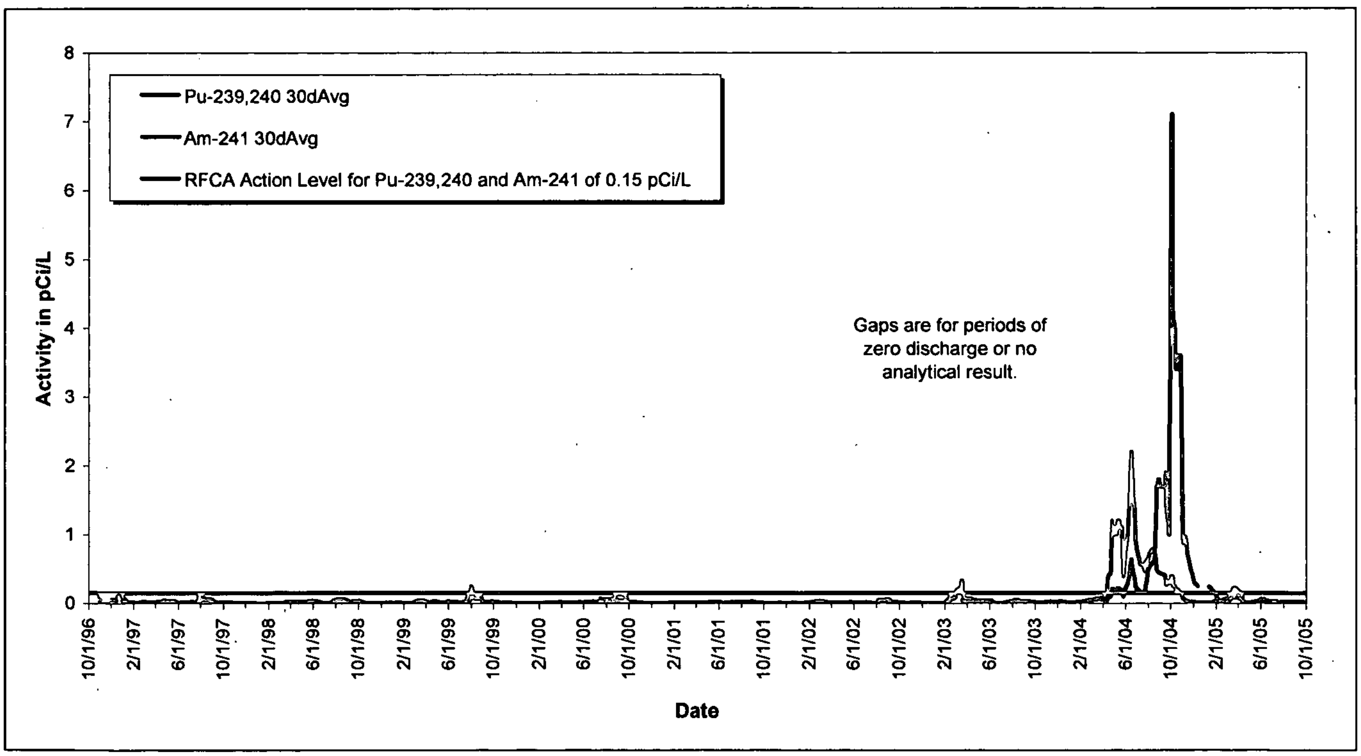


Figure 11-18. Volume-Weighted 30-Day Average Pu and Am Activities at SW093: WY97–05.

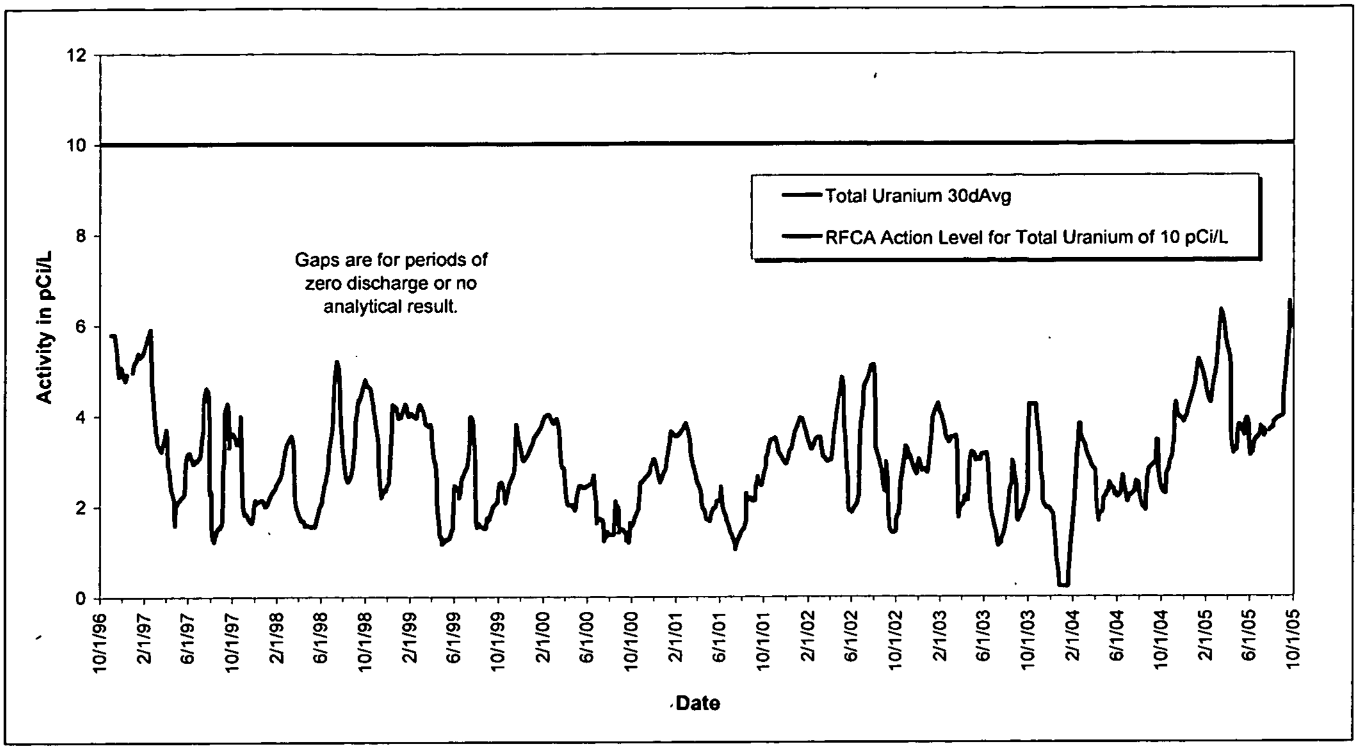


Figure 11-19. Volume-Weighted 30-Day Average Total Uranium Activities at SW093: WY97–05.

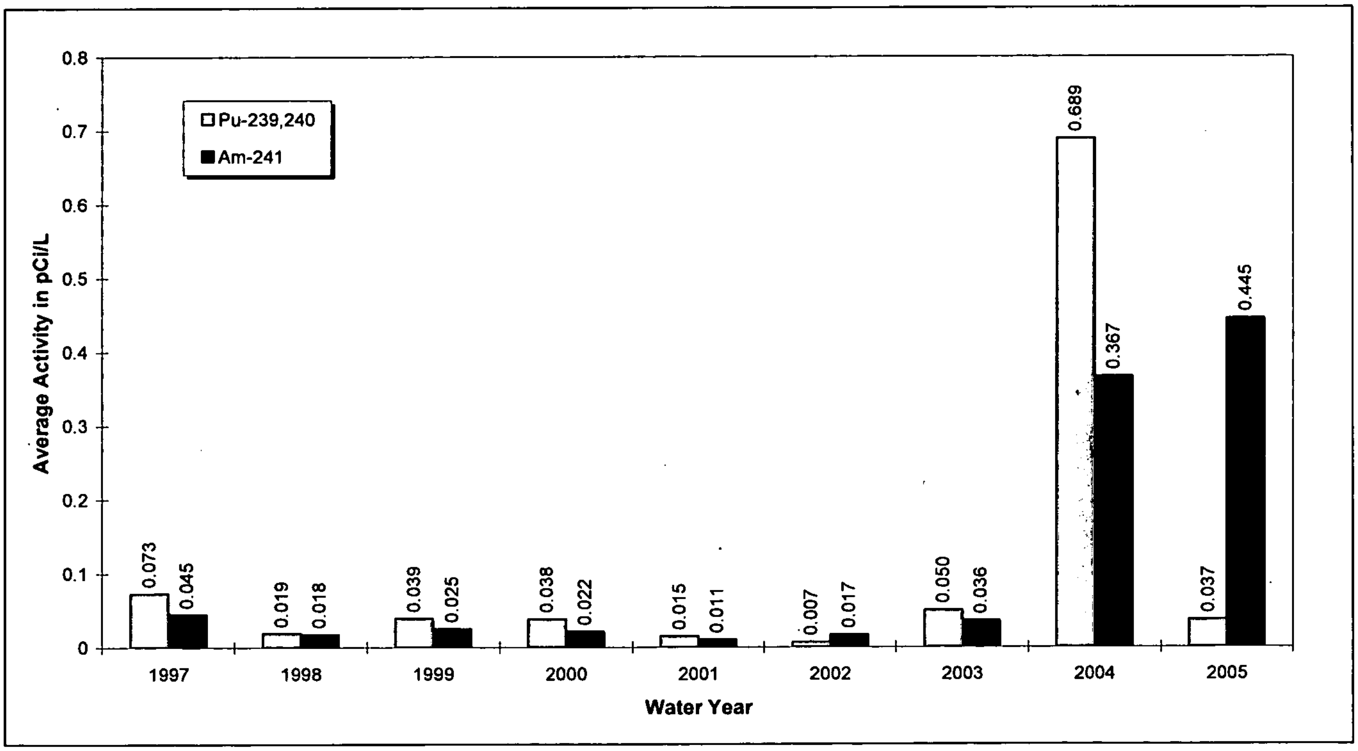


Figure 11-20. Annual Volume-Weighted Average Pu and Am Activities at SW093: WY97–05.

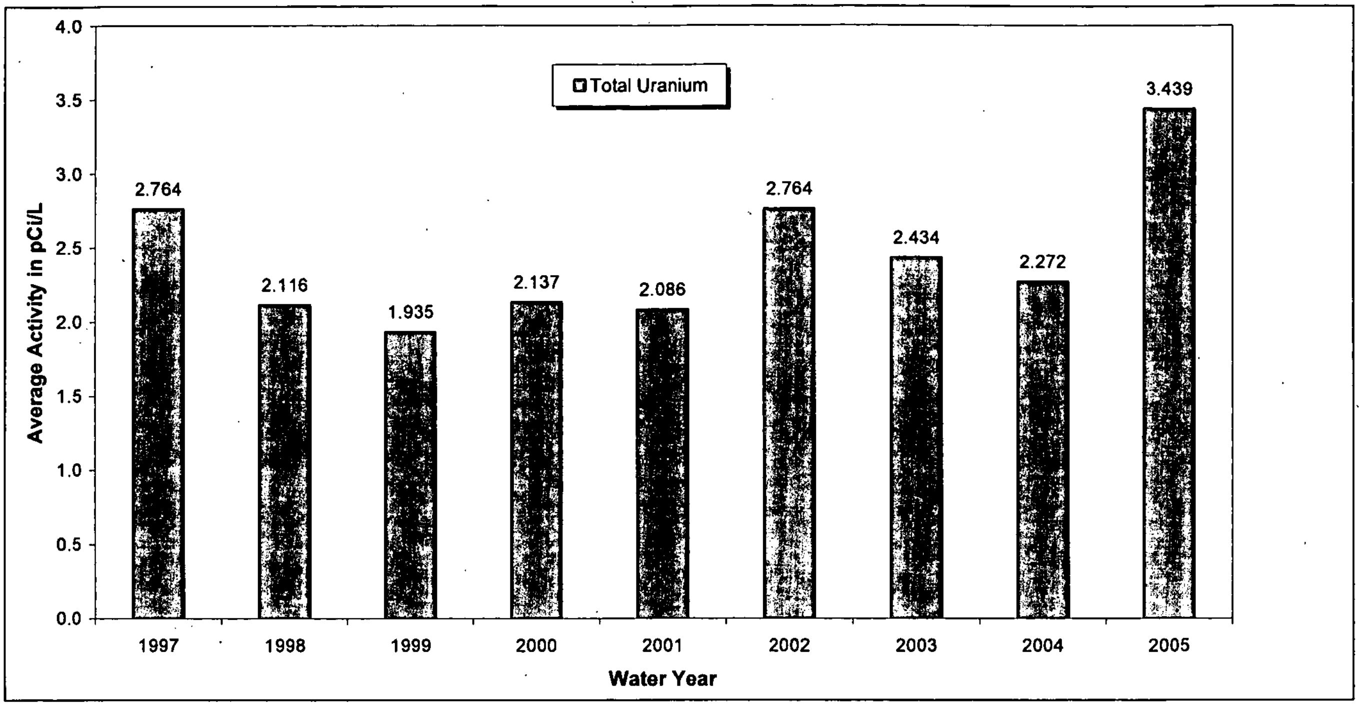


Figure 11-21. Annual Volume-Weighted Average Total Uranium Activities at SW093: WY97–05.

Table 11-14 shows that all of the annual average metals concentrations were less than the action level. Additionally, the long-term metals averages (WY97-05) were less than the action levels.

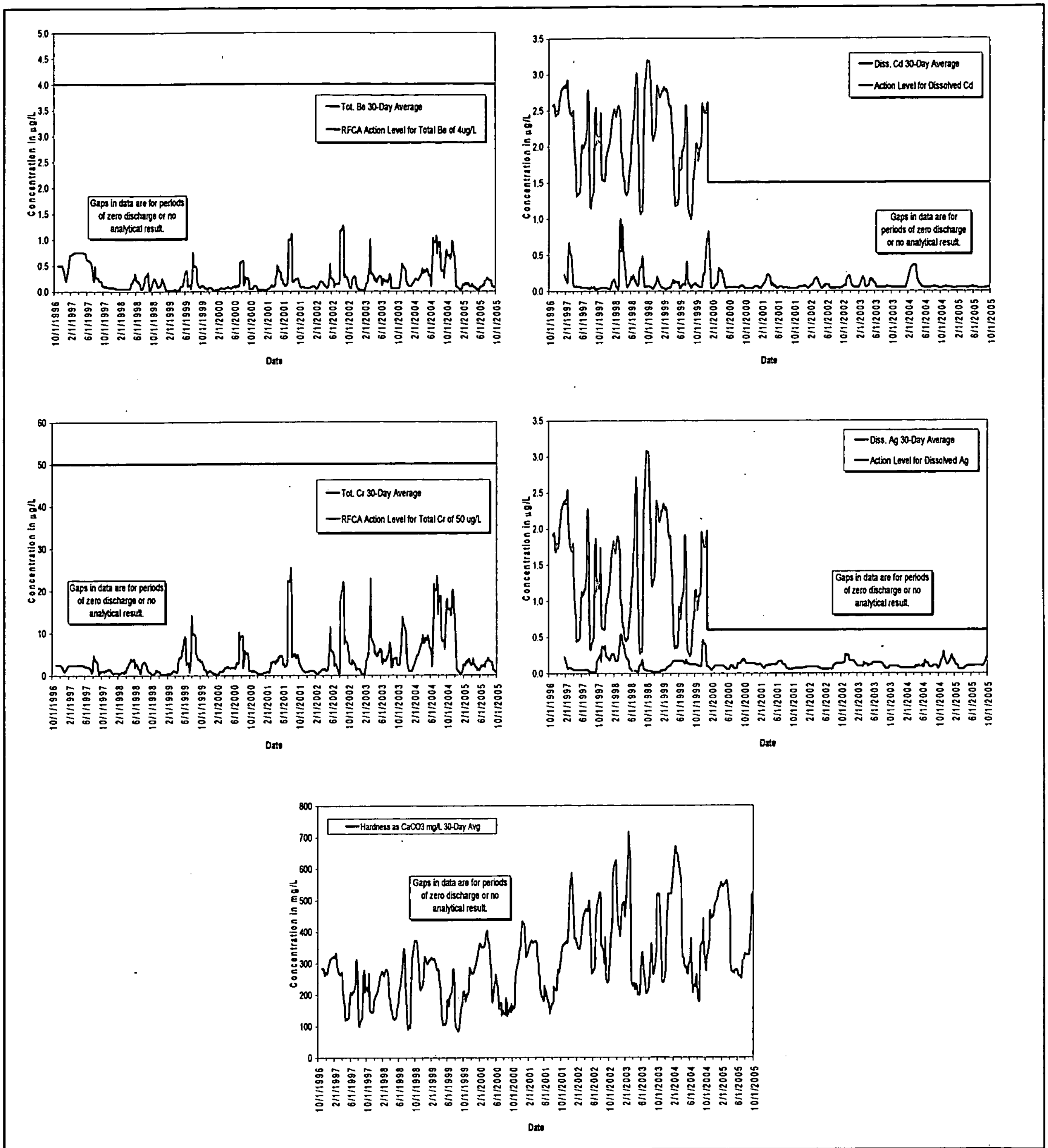
Figure 11-22 shows that none of the 30-day averages for metals were reportable.[56] The recent increases in the 30-day average hardness values is likely the result of winter deicing operations and the WY00 change to new deicing products products (magnesium chloride). Hardness levels have increased as a result of these changes.

Table 11-14. Annual Volume-Weighted Average Hardness and Metals Concentrations at SW093 in WY97-05.

Water Year	Volume-Weighted Average Concentration (µg/L)				
	Hardness [mg/L]	Total Be	Dissolved Cd	Total Cr	Dissolved Ag
1997	172	0.57	0.09	2.79	0.06
1998	175	0.12	0.20	2.12	0.25
1999	151	0.21	0.10	5.16	0.14
2000	220	0.20	0.13	3.85	0.13
2001	239	0.36	0.07	6.38	0.12
2002	351	0.30	0.07	5.84	0.08
2003	283	0.28	0.11	4.49	0.15
2004	304	0.53	0.09	11.4	0.11
2005	334	0.24	0.05	5.25	0.12
Total (WY97-05)	231	0.30	0.11	5.13	0.14

Note: Hardness units mg/L.

[56] A single dissolved Ag result collected in WY04 at SW093 did not meet the RPD criteria of <100% (see Appendix B.1: Data Evaluation Methods). As such this dissolved Ag sample was not used in the calculation of the dissolved Ag 30-day averages for SW093. The initial result was 4.6 µg/L and the duplicate result was 0.2 µg/L (undetect; half the detect limit was used to calculate the RPD: 0.1 µg/L), for an RPD of 191.5%. The average of these results is used in all other evaluations.



Note: Prior to 1/1/00, action levels for dissolved Cd and Ag were calculated using the analyte specific toxicity equation incorporating the 30-day volume-weighted hardness values.

Figure 11-22. Volume-Weighted 30-Day Average Metals and Hardness Concentrations at SW093: WY97–05.

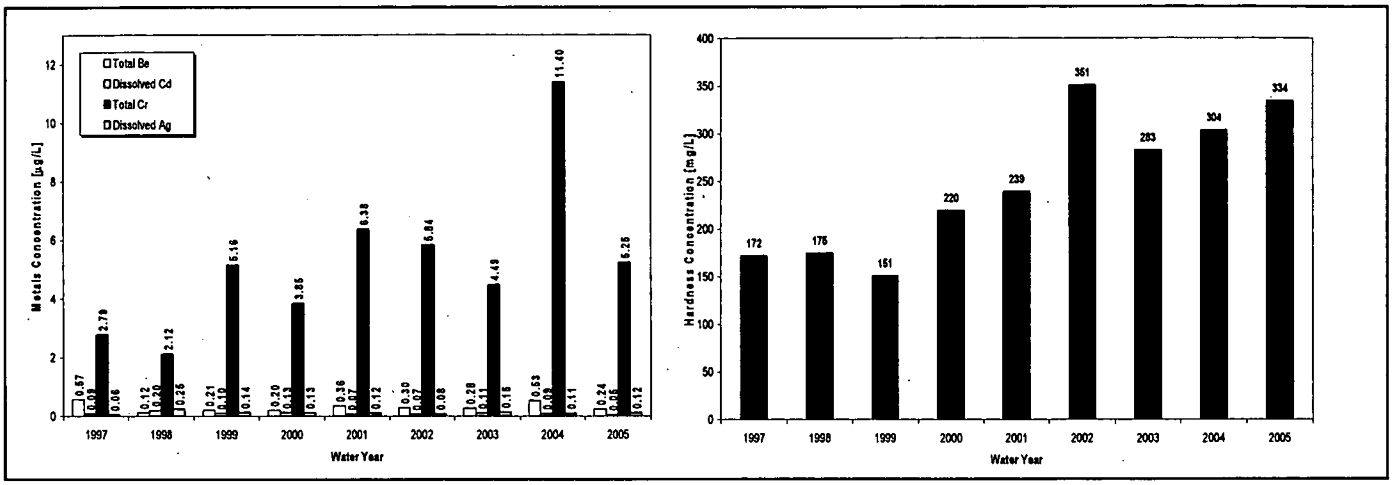
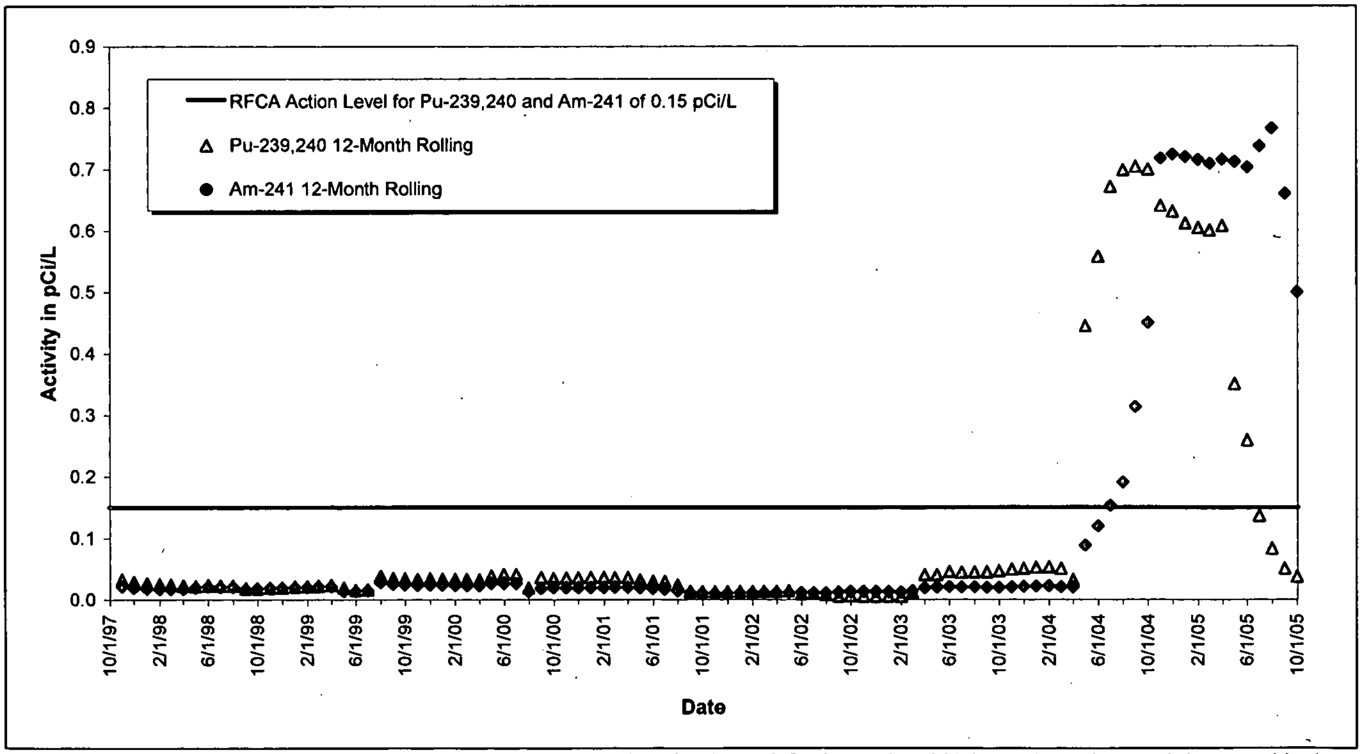
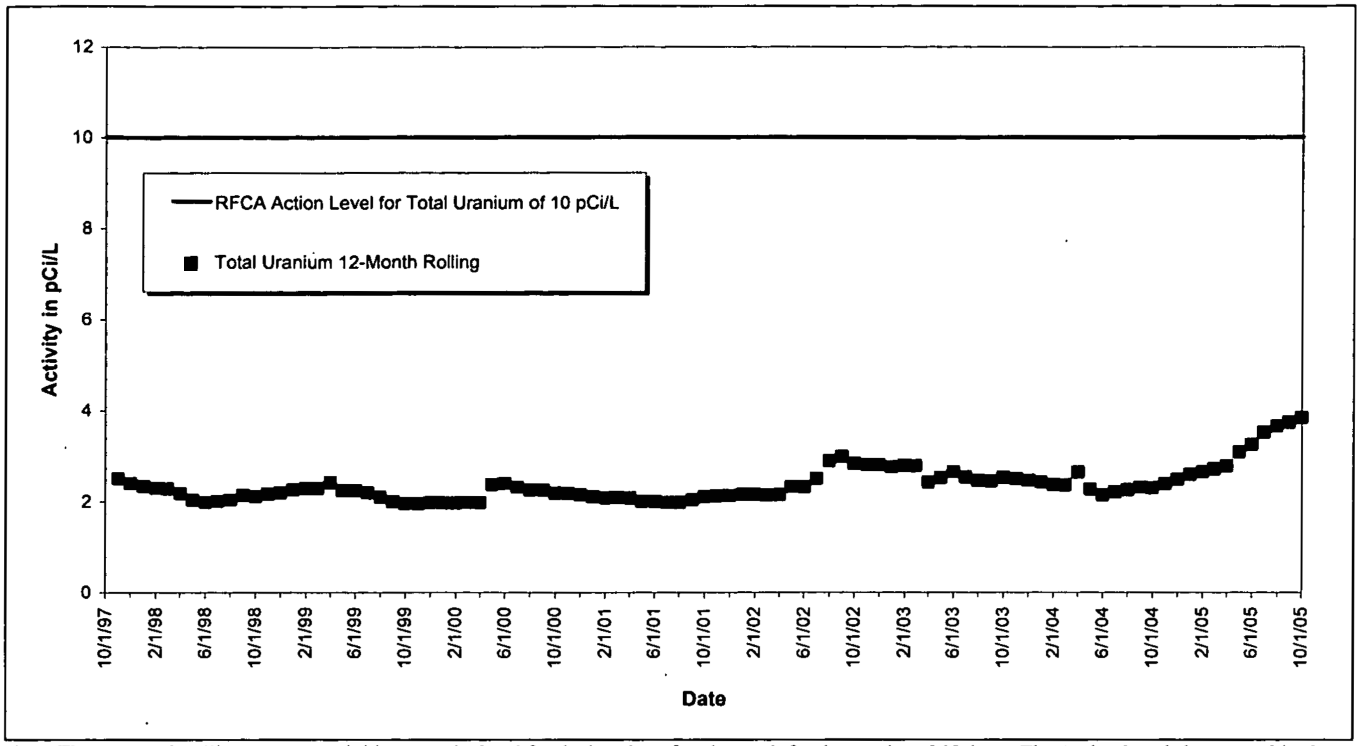


Figure 11-23. Annual Volume-Weighted Average Metals and Hardness Concentrations at SW093: WY97–05.



Note: The 12-month rolling average activities are calculated for the last day of each month for the previous 365 days. The Action Level shown on this plot only applies to 30-day averages. It is shown here for reference only.

Figure 11-24. Volume-Weighted 12-Month Rolling Average Pu and Am Activities at SW093: WY98-05.



Note: The 12-month rolling average activities are calculated for the last day of each month for the previous 365 days. The Action Level shown on this plot only applies to 30-day averages. It is shown here for reference only.

Figure 11-25. Volume-Weighted 12-Month Rolling Average Total Uranium Activities at SW093: WY98-05.

11.4 STREAM SEGMENT 5 POINT OF EVALUATION SUMMARY

11.4.1 Location GS10

- Multiple occurrences of reportable 30-day averages for both Pu and Am have been observed at GS10 during WY97-05, with a measurable increase in WY04-05. In response, the Site was required to perform source evaluations to address these reportable values and aggressively enhanced the pre-existing erosion control program to further reduce the transport of suspended solids from disturbed areas. A summary of the source evaluation investigations is given in Section 6.3.2. With the completion of the functional channels, implementation of enhanced erosion controls, revegetation, and soil stabilization, transport of Pu and Am approaching the action level has been virtually eliminated.
- The 30-day averages for total uranium required reporting during WY05, with a noticeable upward trend. Source evaluation at GS10 identified hydrologic changes at GS10 as the cause of the increases in total uranium. A summary of the source evaluation is given in Section 6.3.2.
- The 30-day averages for total chromium required reporting during WY05. Source evaluation at GS10 identified increased solids transport to GS10 as the cause of the temporary increase. A summary of the source evaluation is given in Section 6.3.2. All other metals were not reportable for the year,

11.4.2 Location SW027

- Several periods of reportable 30-day averages for Pu and Am have been observed at SW027 during WY97-05, with a significant increase in WY04. In response, the Site was required to perform source evaluations to address these reportable values and aggressively enhanced the pre-existing erosion control program to further reduce the transport of suspended solids from disturbed areas. A summary of the source evaluation investigations is given in Section 6.3.4. With the completion of the 903 Pad/Lip actions, implementation of enhanced erosion controls, revegetation, and soil stabilization, transport of Pu and Am approaching the action level has been virtually eliminated.
- The 30-day averages for total uranium were below action levels for the entire period of WY97-05.
- The 30-day averages for metals were below action levels for the entire period of WY97-05.

11.4.3 Location SW093

- Several periods of reportable 30-day averages for Pu and Am have been observed at SW093 during WY97-05, with a significant increase in WY04-05. In response, the Site was required to perform source evaluations to address these reportable values and aggressively enhanced the pre-existing erosion control program to further reduce the transport of suspended solids from disturbed areas. The Site also addressed the increases in Am by disrupting the footing drain pathway from former Building 771. A summary of the source evaluation investigations is given in Section 6.3.3. With the completion of the functional channels, elimination of the B771 pathway, implementation of enhanced erosion controls, revegetation, and soil stabilization, transport of Pu and Am approaching the action level has been virtually eliminated
- The 30-day averages for total uranium were below action levels for the entire period of WY97-05.
- The 30-day averages for metals were below action levels for the entire period of WY97-05.

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12. STREAM SEGMENT 4 POINT OF COMPLIANCE MONITORING

RFCA provides specific standards for Walnut and Woman Creeks below the terminal ponds (Segment 4). These criteria and the responses to them are different than the criteria and actions associated with Segment 5. This section deals only with monitoring discharges from the terminal ponds into Segment 4 and the additional POCs for Segment 4 at Indiana Street. Terminal pond discharges are monitored by POCs GS08, GS11, and GS31. Walnut Creek is monitored at Indiana Street by POC GS03. Woman Creek is monitored at Indiana Street by POC GS01. These locations are shown on Figure 12-1.

With the completion of the Woman Creek Reservoir, located just east of Indiana Street and operated by the city of Westminster, all Woman Creek flows are detained in cells of the reservoir until the water quality has been assured by monitoring Woman Creek at Indiana Street. There is concern that solely monitoring Pond C-2 discharge does not adequately demonstrate that all water leaving the Site via Woman Creek meets the radiologic standards. All Woman Creek water, either combined with Pond C-2 discharge or flowing in the absence of any Pond C-2 water, enters the Woman Creek Reservoir. This is the basis for setting an additional RFCA POC for Woman Creek at Indiana Street (GS01) for those radiologic contaminants that could be directly attributable to the Site (i.e., not naturally occurring).

For Walnut Creek, a similar POC, GS03, has been established at Walnut Creek and Indiana Street. As for Woman Creek, it is possible that contaminated overland runoff or landfill drainage may enter Walnut Creek below the terminal pond monitoring points (GS08 and GS11), yet upstream of Indiana Street.

12.1 DATA TYPES, FREQUENCY, AND COLLECTION PROTOCOLS

The analytical decision inputs are those analytes specified as the Segment 4 AoIs (Table 12-1), as sampled at the POCs for Stream Segment 4. Monitoring performed for Stream Segment 4 is limited to POCs GS01, GS03, GS08, GS11, and GS31.

Sampling for AoIs at POCs is performed by collecting continuous flow-paced composite samples. The recommended monitoring design detailed in the IMP is to take samples for WY05 as specified in Table 12-4 and Table 12-5. Flow-paced monitoring is maintained at all times for all five POCs in Segment 4, although no samples are anticipated from terminal pond stations except during planned pond discharges.

Historically, terminal pond discharges occurred on average once per year for Pond C-2 and 9 times per year for A-4 and B-5 combined. Since the DQO process originally targeted 3 composite samples per discharge (for WY97), terminal pond POCs targeted 30 composite samples to be collected annually.

During WY97, all routine North and South Walnut Creek water was discharged from A-4 (B-5 was pump transferred to A-4, except during periods of high stormwater runoff). Starting in WY98, Pond B-5 began routine direct discharge to Walnut Creek, effectively dividing discharges to Walnut Creek between Ponds A-4 and B-5. Therefore, sampling protocols starting in WY98 were modified such that the total number of continuous flow-paced composite samples to be collected annually for discharges from both A-4 and B-5 would be comparable to the WY97 targets. For Fiscal Years 1993 through 1997, the total combined discharge volume for A-4 and B-5 was 687 MG in 43 discharge batches, or 16 MG per discharge batch on average. Targeting three composite samples per discharge gives one composite sample per 5.3 MG of discharge volume. This composite sample frequency (1 per 5.3 MG) will preserve the targeted sampling frequencies (based on discharge volume) while maintaining effective cost controls (based on total sample costs).

For FY05 planning purposes, 7 samples were to be collected from A-4, and 6 from B-5, resulting in the collection of the targeted 13 composite samples (see Table 12-5).

The source(s) of the water sampled at the Indiana Street POCs (GS01 and GS03) must be determined prior to sample planning at these locations. Monitoring at GS01 and GS03 calls for samples to be segregated based on water origin (natural creek flows or terminal pond discharges commingled with natural flows).

POC GS01 targets 3 samples during each Pond C-2 discharge; storm runoff and baseflow samples are based on average annual volumes. During storm runoff and baseflow, the target at GS01 is 25 samples per year (frequency

180

based on expected discharge), with a maximum of 4 samples during any one month (see Table 12-5). GS03 targets 13 samples during A-4 and B-5 discharges (GS03 collects the same number of composite samples as the terminal pond POCs for each discharge). During storm runoff and baseflow periods between pond discharges, GS03 targets 2 composite samples every 15 days. The goal is to have at least 2 analytical results for any 30-day period for averaging purposes. The Site may combine samples of the same flow pacing to reduce analytical costs and avoid samples of non-sufficient quantity for analysis.

Table 12-1. RFCA Segment 4 AoIs.

Terminal Pond POCs		
Radionuclides:	Total Pu-239,240	Known carcinogen. Known past measurements (within the past 8 years) have exceeded RFCA Action Levels. This provides reasonable cause to expect future measurements in excess of RFCA Standards.
	Total U-233,234, U-235, U-238	Known renal toxicity. Present on Site. Past measurements provide reasonable cause to expect future measurements in excess of RFCA Standards.
	Total Am-241	Known carcinogen. Present on Site. Known past measurements have exceeded RFCA Action Levels. This provides reasonable cause to expect future measurements in excess of RFCA Standards.
Real Time Monitoring of Physical and Indicator Parameters: These parameters provide real-time indicators for a variety of regulated contaminants, and are also a required component of monitoring for AoIs. They require no laboratory analyses, and are the Site's most cost effective defensive monitoring.	pH	Extremes are toxic to humans and ecology. Regulatory concern due to chromic acid incident. Real-time monitoring is inexpensive and effective method of detecting acid spills such as (chromic acid or Pu nitrate) or failure of treatment systems.
	Conductivity	Conductivity is an indicator of total dissolved ions, metals, anions, and pH. Real-time monitoring of conductivity is an inexpensive indicator of overall water quality.
	Turbidity	Turbidity is a general indicator of elevated contaminant levels, and may be correlated with Pu.
	Nitrate	Past releases near RFCA stream standards and action levels upstream of ponds provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels. Certain discharges often include nitrate, and may challenge RFCA action levels.
	Flow	Required to detect flow events, pace automatic samplers, evaluate contaminant loads, and plan pond operations and discharges. Affects nearly every decision rule, and is the most commonly discussed attribute of Site surface waters.
Indiana Street POCs		
Radionuclides:	Total Pu-239,240	High level of public concern. Known carcinogen. Known past releases (within the past 8 years) have exceeded RFCA stream standards and action levels. This provides reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
	Total Am-241	Known carcinogen. Present on-site. Known past exceedances provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
	Total U-233,234, U-235, U-238	Known renal toxicity. Present on Site. Past measurements provide reasonable cause to expect future measurements in excess of RFCA Standards.
Real Time Monitoring of Physical and Indicator Parameters:	Water-Quality Parameters	Indiana Street is not a POC for the real-time monitoring parameters.
	Flow	Required to detect flow events, pace automatic samplers, and evaluate contaminant loads. Affects nearly every decision rule, and is the most commonly discussed attribute of Site surface waters.

12.2 WY05 MONITORING SCOPE

Table 12-2. POC Monitoring Locations.

Location Code	Location	Primary Flow Measurement Device	Telemetry
GS11	Pond A-4 outlet works	24" Parshall Flume	Yes
GS08	Pond B-5 outlet works	24" Parshall Flume	Yes
GS31	Pond C-2 outlet works	24" Parshall Flume	Yes
GS03	Walnut Creek and Indiana St.	6" and 36" Parallel Parshall Flumes; 3' HL-Flume installed 2/12/03	Yes
GS01	Woman Creek and Indiana St.	9" Parshall Flume	Yes

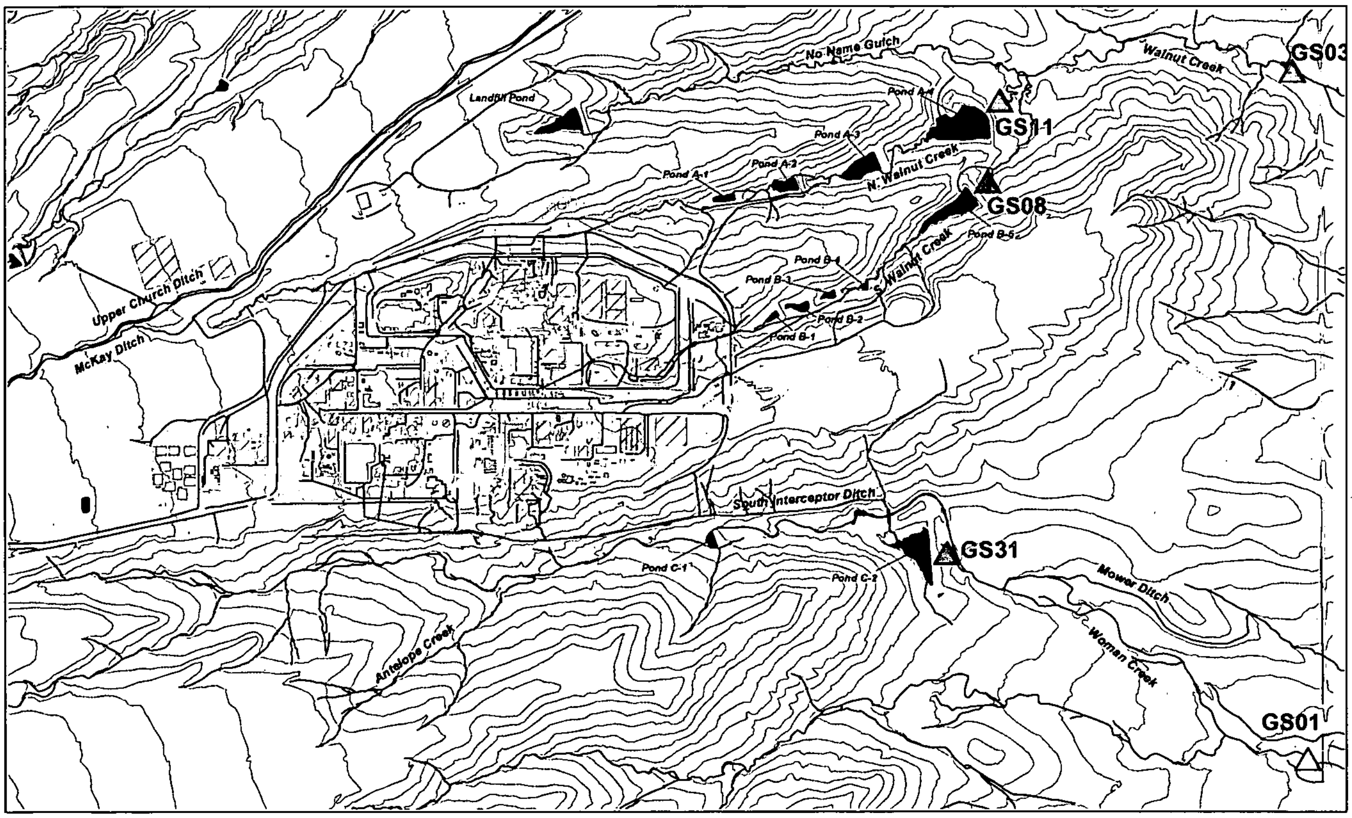


Figure 12-1. WY05 Point of Compliance Monitoring Locations.

Table 12-3. POC Field Data Collection: Parameters and Frequency.

Location Code	Parameter	
	Discharge	Real-Time pH, Conductivity, Turbidity, Nitrate
GS01	15-min continuous	None
GS03	15-min continuous	None
GS08	15-min continuous	15-min continuous
GS11	15-min continuous	15-min continuous
GS31	15-min continuous	15-min continuous

Note: All locations collect both 5- and 15-minute interval flow data.

Table 12-4. POC Sample Collection Protocols.

Location Code	Frequency: WY05 Actual (Target)	Type[b]
GS01	23 (28 per year[c])	Continuous flow-paced composites
GS03	23 (48 per year[a])	Continuous flow-paced composites
GS08	11 (6 per year[a])	Continuous flow-paced composites
GS11	3 (7 per year[a])	Continuous flow-paced composites
GS31	4 (3 per year[c])	Continuous flow-paced composites

Notes: [a] Assuming one composite sample per 5.3 MG of terminal pond discharge volume. Number may vary due to pond-water management activities.
[b] Sample types are defined in Appendix B.
[c] Assumes one C-2 discharge per year; 3 composite samples per discharge.

Table 12-5. POC Target Sample Distribution.[57]

Time Period	Pond: WY05 Actual (Target) A-4 [GS11]	B-5 [GS08]	C-2 [GS31]	Walnut Cr. at Indiana St. [GS03]: WY05 Actual (Target)[58]	Woman Cr. at Indiana St. [GS01]: WY05 Actual (Target)[59]	Total Number of Samples: WY05 Actual (Target)
During Discharge	3 (7[a])	11 (6[a])	4 (3[b])	13 (13[a])	4 (3[b])	35 (32)
Storm and Baseflow[c]						
October 04	NA	NA	NA	2 (3)	0 (1)	2 (4)
November 04	NA	NA	NA	1 (3)	0 (1)	1 (4)
December 04	NA	NA	NA	0 (3)	3 (1)	3 (4)
January 05	NA	NA	NA	0 (3)	2 (2)	2 (5)
February 05	NA	NA	NA	0 (3)	3 (2)	3 (5)
March 05	NA	NA	NA	0 (3)	3 (4)	3 (7)
April 05	NA	NA	NA	2 (3)	5 (4)	7 (7)
May 05	NA	NA	NA	2 (2)	2 (4)	4 (6)
June 05	NA	NA	NA	2 (3)	1 (3)	3 (6)
July 05	NA	NA	NA	1 (3)	0 (1)	1 (4)
August 05	NA	NA	NA	0 (3)	0 (1)	0 (4)
September 05	NA	NA	NA	0 (3)	0 (1)	0 (4)
Annual Totals	3 (7)	11 (6)	4 (3)	23 (48)	23 (28)	64 (92)

Notes: [a] Assuming one composite sample per 5.3 MG of terminal pond discharge volume. Number may vary due to pond-water management activities.
[b] Assumes one C-2 discharge per year; 3 composite samples per discharge.
[c] GS01 and GS31 distribution based on PNNL recommendations; GS03 distribution based on average monthly number of days without a terminal pond discharge using historic data (period when neither A-4 nor B-5 direct discharged) assuming approximately one composite every 8 days.

[57] The number of samples collected at each pond depends on the amount of water discharged from each pond. Of the combined North and South Walnut Creek inflows, 65% flows to B-5 and 35% flows to A-4, on average. Depending on pond operation protocols, it is possible that no water could be directly discharged from Pond B-5, and no samples would be collected at GS08. All B-5 water would be pumped to A-4, and all POC samples for both A-4 and B-5 would then be collected at GS11. Regardless, the targeted 13 samples is specified for budget planning purposes.

[58] As of the publication of this report, the composite sample at GS03 started on 7/28/05 was still in progress. GS03 has not flowed since 8/15/05 and the composite currently contains 3.8 liters, a non-sufficient quantity for analysis. Therefore, the analytical results for this sample are not included in this section.

[59] As of the publication of this report, the composite sample at GS01 started on 7/1/05 was still in progress. GS01 has not flowed since 7/14/05 and the composite currently contains 3.8 liters, a non-sufficient quantity for analysis. Therefore, the analytical results for this sample are not included in this section.

Table 12-6. POC Analytical Targets (Analyses per Year).

Location Code	TSS[a]: WY04 Actual (Target)	Pu, U, Am: WY04 Actual (Target)
GS01	4 (28)	23 (28)
GS03	10 (48)	23 (48)
GS08	7 (6)	11 (6)
GS11	0 (7)	3 (7)
GS31	0 (3)	4 (3)

Notes: [a] Ideally, TSS would be analyzed for all samples collected at the above locations. However, continuous flow-paced sampling protocols often result in composite samples which are collected over periods exceeding the 7-day hold time for TSS analyses. Therefore, TSS can not be analyzed for all continuous flow-paced composite samples, but will be analyzed when possible.

12.3 DATA EVALUATION

Sampling for AoIs at POCs is performed by collecting continuous flow-paced composite samples. Indicator parameters are measured using real-time water-quality probes. These AoIs and indicator parameters are evaluated using 30-day or 1-day moving averages, as specified in RFCA and implemented by the ALF or DQOs. Total Pu, Am, and U are evaluated using volume-weighted 30-day moving averages at POCs[60]. Indicator parameters pH and nitrate are evaluated as 1-day arithmetic averages. Indicators are not evaluated under this monitoring objective for the Indiana Street POCs.

The parties to RFCA agree that continuous monitoring probes will be used as indicators that may suggest a need for additional monitoring, mitigating action, or management decision. The parties agree that compliance and enforcement issues will be resolved on the basis of standard analytical procedures specified by the applicable regulation or agreement (e.g., NPDES, RFCA, or CERCLA). The parties agree that continuous monitoring field probes should NOT be used to determine compliance or serve as a basis for enforcement action, unless the applicable regulation specifies such a probe as the enforceable analytical method for a particular measurement.

Generally, analytical data evaluation is performed as data become available. If an initial qualitative screening indicates that an analytical result is higher than the standard for a particular AoI, then the 30-day average is calculated immediately. If the 30-day average values are reportable, then validation is requested for all data packages used in the calculation. The desired evaluation frequency is semi-monthly, within one week of the 15th and last day of any given month. RFCA requires that DOE, RFPO inform regulators within 15 days of DOE, RFPO gaining knowledge (not just a suspicion) that an exceedance (verified) has (actually) occurred. The DQO decision rule is:

IF The volume-weighted 30-day moving average for any AoI in Stream Segment 4, as represented by samples from the specified RFCA POCs (i.e., terminal pond discharges and Indiana Street) exceeds the appropriate RFCA standard (Table 12-8)

THEN The Site must:

- — Notify EPA, CDPHE, and either Broomfield or Westminster, whichever is affected;
- — Submit a plan and schedule to evaluate for source location, and implement mitigating action if appropriate; and
- — The Site may receive a notice of violation.

[60] The 30-day average for a particular day is calculated as a volume-weighted average of a 'window' of time containing the previous 30-days which had both flow and an analytical result. Each day has its own discharge volume (measured at the location with a flow meter) and activity (analytical result from the sample in place at the end of that day). Therefore, there are 365 30-day moving averages for a location which flows all year (366 in a leap year). At locations which monitor pond discharges or have intermittent flows, 30-day averages are calculated as averages of the previous 30 days of greater than zero flow. For days where no activity is available, either due to failed lab analysis or NSQ for analysis, no 30-day average is reported. The calculation of 30-day averages is discussed in detail in Appendix B.1: Data Evaluation Methods.

Table 12-7. POC Monitoring Analytical Data Evaluation.

Location Code	Evaluation Type[a]
GS01	30-Day Volume-Weighted Moving Averages; Loading Analysis
GS03	30-Day Volume-Weighted Moving Averages; Loading Analysis
GS08	30-Day Volume-Weighted Moving Averages; Loading Analysis
GS11	30-Day Volume-Weighted Moving Averages; Loading Analysis
GS31	30-Day Volume-Weighted Moving Averages; Loading Analysis

Notes: [a] Details on the evaluation of analytical results are given in Appendix B.1: Data Evaluation Methods. Loading analysis for POCs is given in Section 5.

Table 12-8. POC Monitoring RFCA Standards.

Analyte	Standard
Am-241	0.15 pCi/L
Pu-239,240	0.15 pCi/L
Total Uranium	10 pCi/L (Walnut Cr.); 11 pCi/L (Woman Cr.)

Note: The above standards only apply to 30-day average values. Comparisons to other values are provided for reference only.

The following sections include summary tables and plots showing the 30-day moving averages, periodic volume-weighted averages, and rolling 12-month volume-weighted averages[61] for the POC analytes.

The following evaluations include all results that were not rejected through the verification and validation process. Data are generally presented to decimal places as reported by the laboratories. Accuracy should not be inferred; minimum detectable concentrations/activities and analytical error are often greater than the precision presented. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the 'real' and the 'duplicate' values. When a sample has multiple 'real' analyses (Site requested 'reruns'), the value used in calculations is the arithmetic average of the multiple 'real' analyses. Total uranium is calculated by summing the activities for the analyzed isotopes (U-233,234 + U-235 + U-238). The methods used for the evaluations are given in Appendix B.1: Data Evaluation Methods. The loading analysis for the POCs is presented in Section 5.

Plots of mean daily water temperature, specific conductivity, pH, and turbidity values (terminal pond POCs only) are given below.[62] Plots of mean daily water temperature, specific conductivity, and pH for the Indiana Street POCs (GS01 and GS03) are given in Section 13: Non-POC Monitoring at Indiana Street. More detailed data for all parameters are presented in Appendix B.5.2. The methods used for the water-quality parameter evaluations are given in Appendix B.5: Real-Time Water-Quality Parameters.

12.3.1 Location GS01

Monitoring location GS01 is located on Woman Creek at Indiana Street. Figure 3-10 shows the drainage area for GS01. The Woman Creek headwaters, the southern portion of the IA, and Pond C-2 contribute flow to GS01.

Table 12-9 shows that all of the annual average Pu and Am activities were well below the 0.15 pCi/L standard.[63] Additionally, the long-term Pu and Am averages (WY97-05) are well below the 0.15 pCi/L standard. The average total uranium activities are all well below the 11 pCi/L standard. Figure 12-2 through Figure 12-3 show no occurrences of reportable 30-day averages.

[61] Evaluation of analytical data using rolling 12-month volume-weighted averages is being proposed for post-Closure monitoring objectives at the Pond A-4, B-5, and C-2 outfalls.

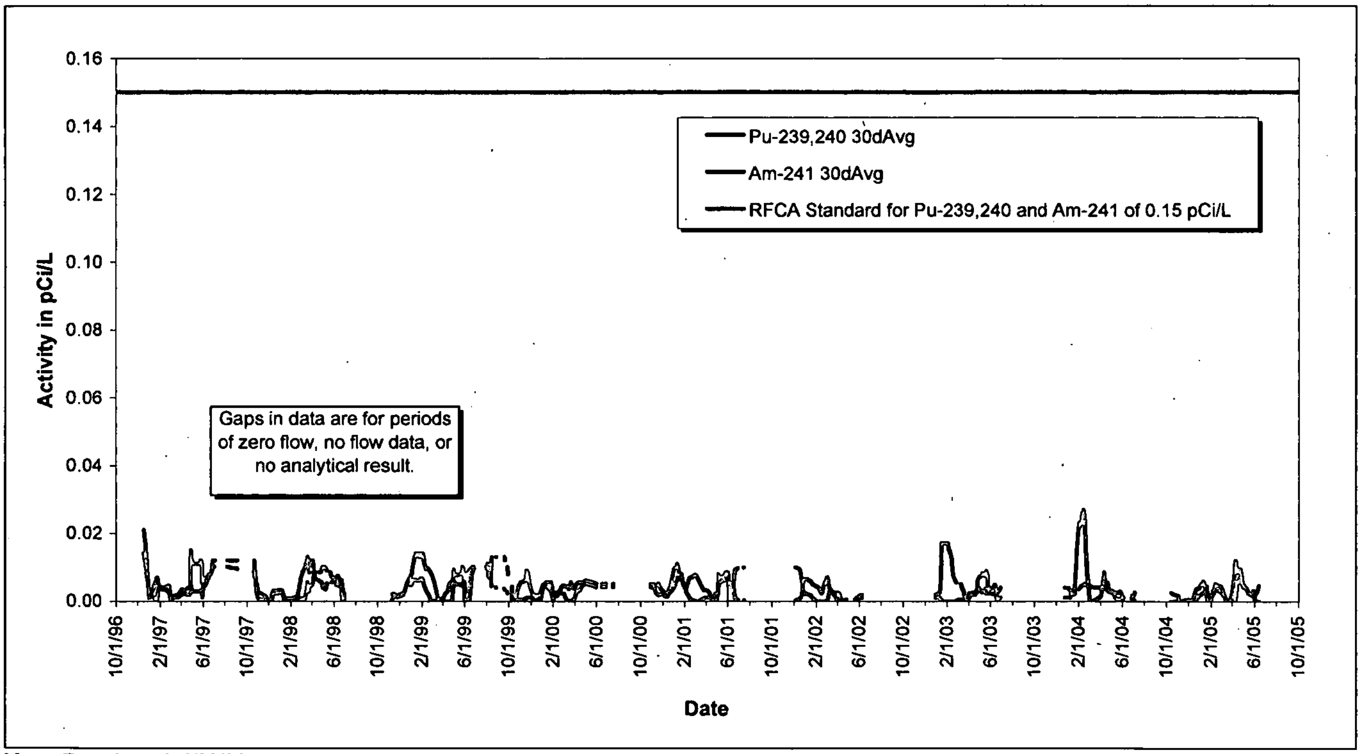
[62] Mean daily water-quality values are given for days of measurable flow. Some data may be missing due to equipment failures and removal for calibration.

[63] As of the publication of this report, the composite sample at GS01 started on 7/1/05 was still in progress. GS01 has not flowed since 7/14/05 and the composite currently contains 3.8 liters, a non-sufficient quantity for analysis. Therefore, the analytical results for this sample are not included in this section.

Table 12-9. Annual Volume-Weighted Average Radionuclide Activities at GS01 in WY97-05.

Water Year	Volume-Weighted Average Activity (pCi/L)		
	Am-241	*Pu-239,240*	*Total Uranium*
1997	0.003	0.010	NA
1998	0.005	0.006	NA
1999	0.005	0.008	NA
2000	0.004	0.003	NA
2001	0.004	0.006	NA
2002	0.003	0.001	NA
2003	0.002	0.004	1.24
2004	0.004	0.003	2.64
2005	0.003	0.003	2.93
Total (WY97-05)	0.004	0.006	2.02

Collection of total uranium data began on 2/3/03. Data through 6/30/05.



Note: Data through 6/30/05.

Figure 12-2. Volume-Weighted 30-Day Average Pu and Am Activities at GS01: WY97–05.

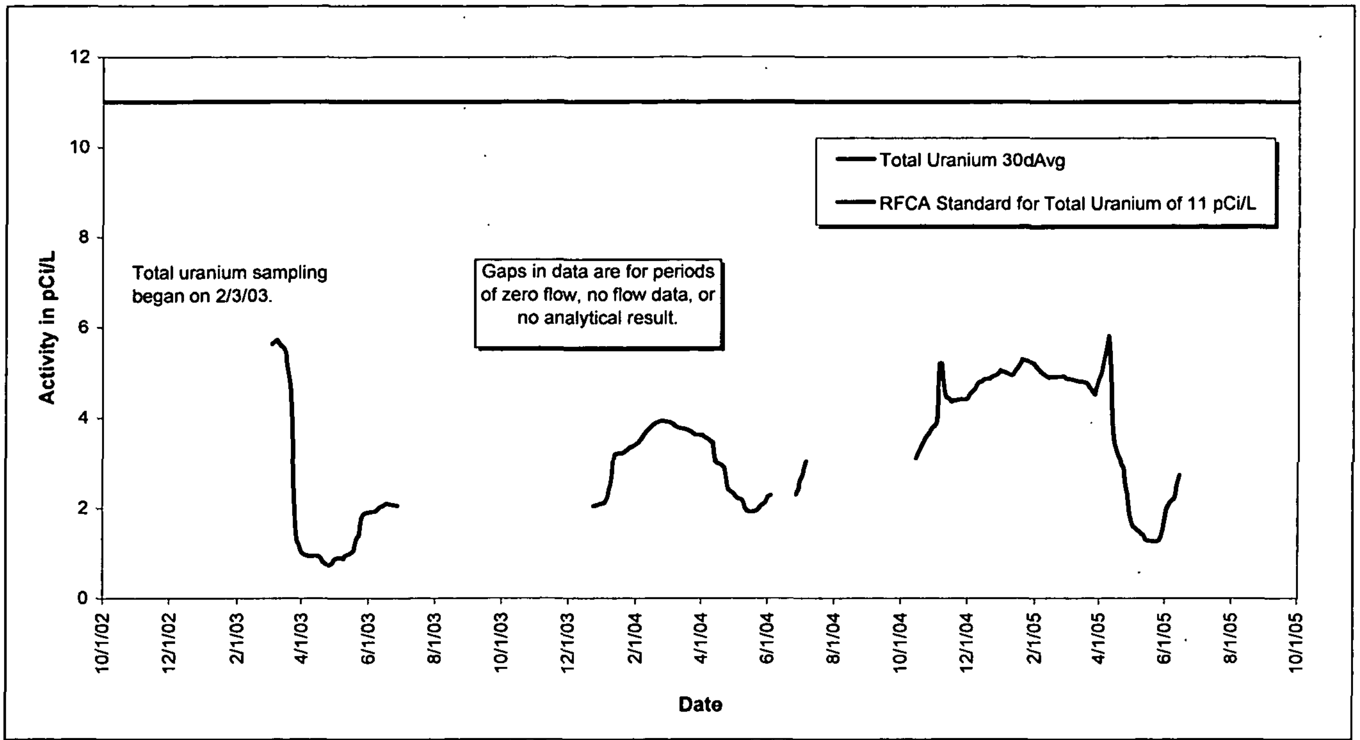


Figure 12-3. Volume-Weighted 30-Day Average Total Uranium Activities at GS01: WY03-05.

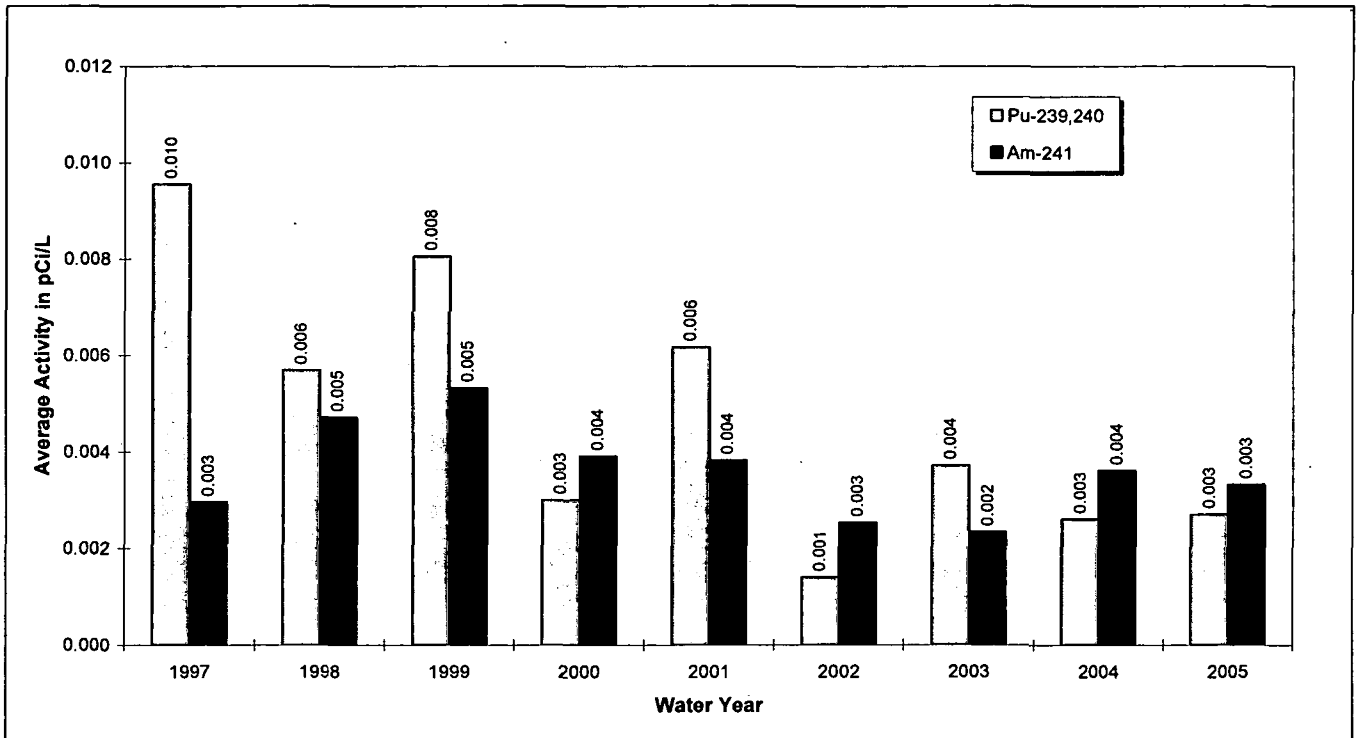


Figure 12-4. Annual Volume-Weighted Average Pu and Am Activities at GS01: WY97–05.

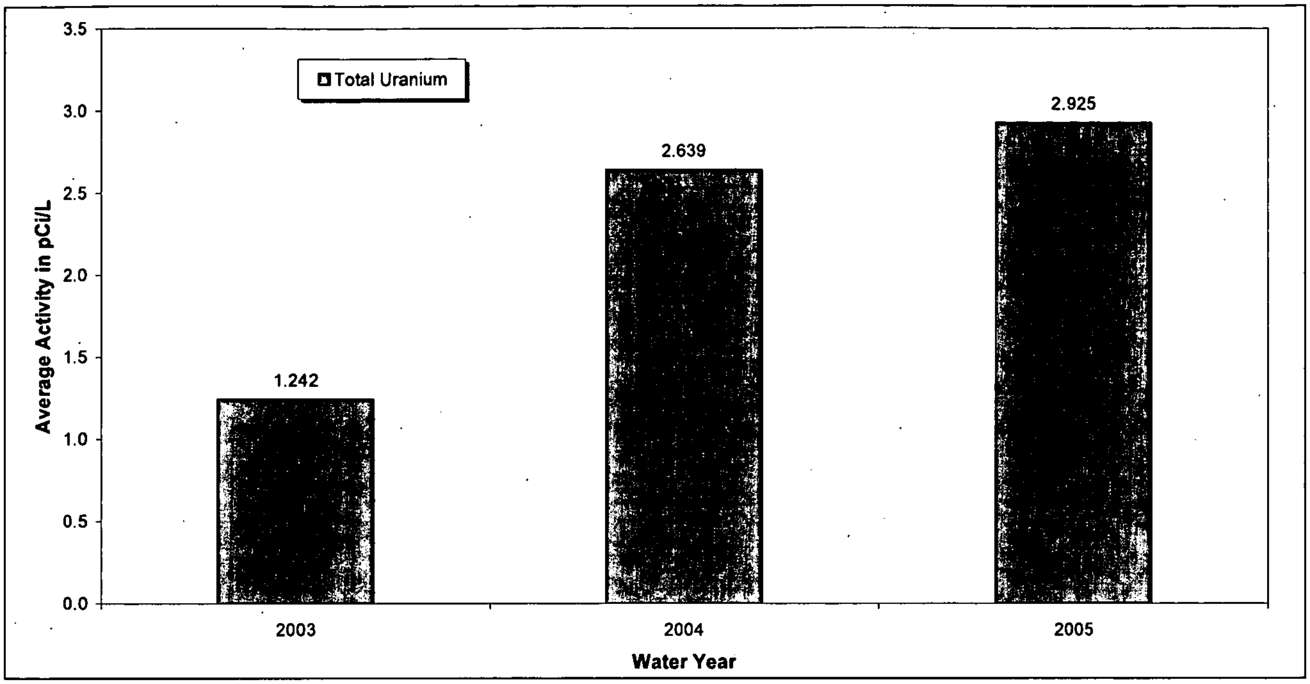


Figure 12-5. Annual Volume-Weighted Average Total Uranium Activities at GS01: WY03–05.

12.3.2 Location GS03

Monitoring location GS03 is located on Walnut Creek at Indiana Street. Figure 3-16 shows the drainage area for GS03. The Walnut Creek headwaters, the majority of the IA, Pond A-4, and Pond B-5 contribute flow to GS03.

Table 12-10 shows that all of the annual average Pu and Am activities were well below the 0.15 pCi/L standard.[64] Additionally, the long-term Pu and Am averages (WY97-05) are well below the 0.15 pCi/L standard. The average total uranium activities are all well below the 10 pCi/L standard.

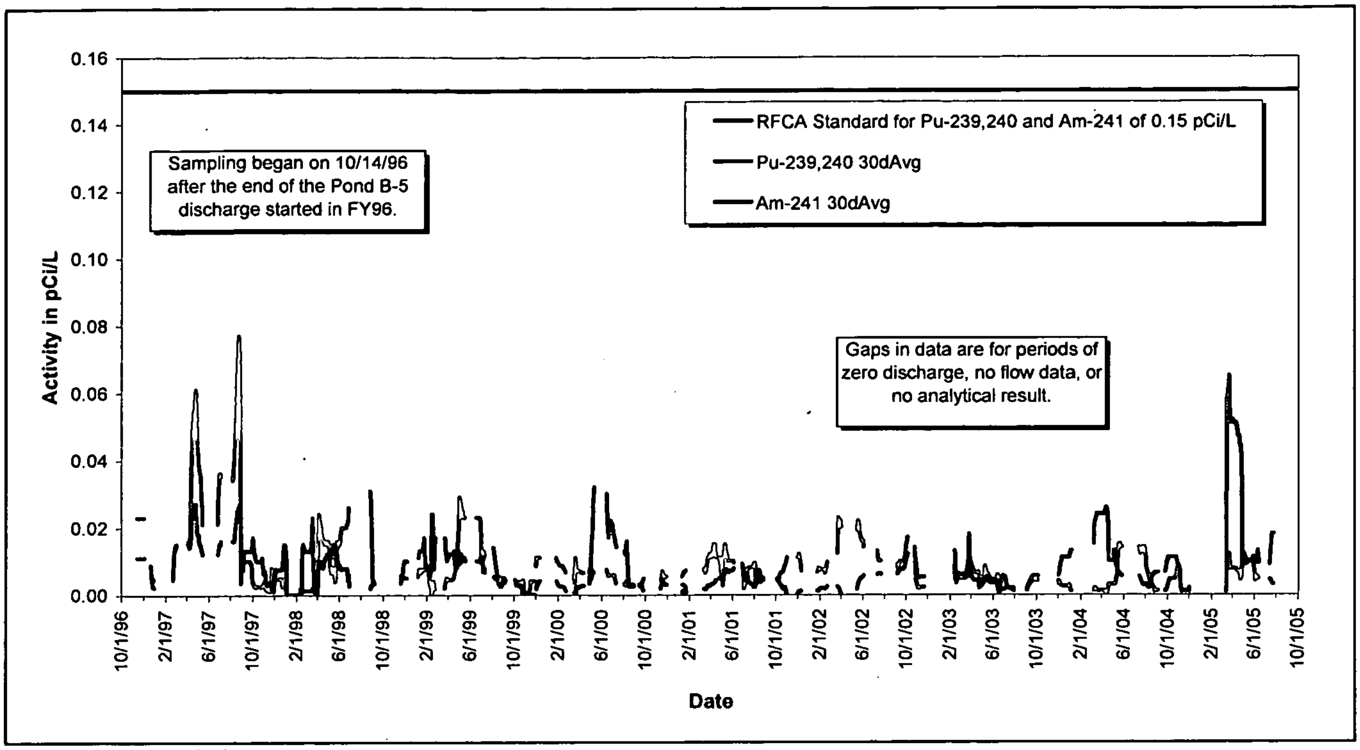
Figure 12-6 through Figure 12-7 show no occurrences of reportable 30-day averages. The slight increase in WY05 Am activities is due to the discharge of treated A-4 water with Am activities slightly higher than normal.

Table 12-10. Annual Volume-Weighted Average Radionuclide Activities at GS03 in WY97-05.

Water Year	Volume-Weighted Average Activity (pCi/L)		
	Am-241	*Pu-239,240*	*Total Uranium*
1997	0.015	0.030	NA
1998	0.009	0.012	NA
1999	0.010	0.015	NA
2000	0.007	0.005	NA
2001	0.005	0.009	NA
2002	0.004	0.012	NA
2003	0.005	0.006	1.81
2004	0.008	0.007	1.75
2005	0.021	0.008	3.80
Total (WY97-05)	0.009	0.012	2.52

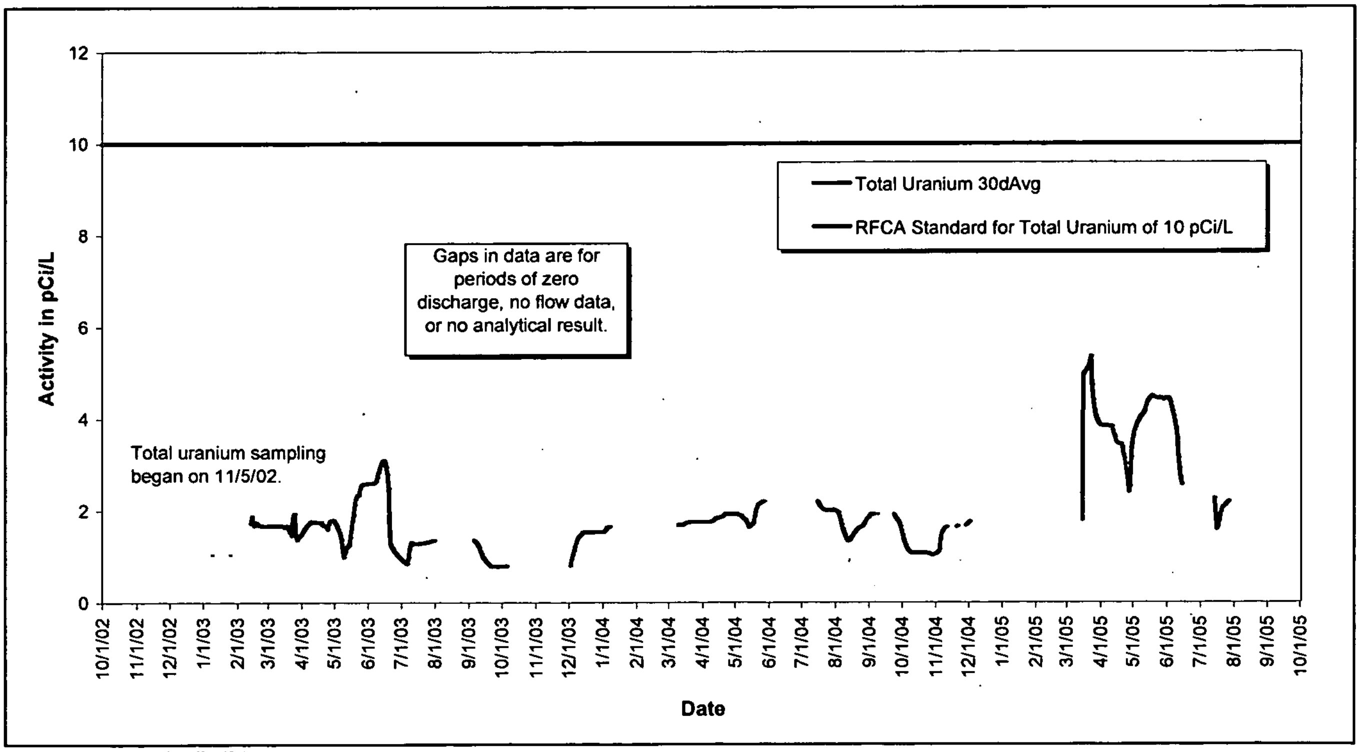
Collection of total uranium data began on 11/5/02. Data through 7/27/05.

[64] As of the publication of this report, the composite sample at GS03 started on 7/28/05 was still in progress. GS03 has not flowed since 8/15/05 and the composite currently contains 3.8 liters, a non-sufficient quantity for analysis. Therefore, the analytical results for this sample are not included in this section.



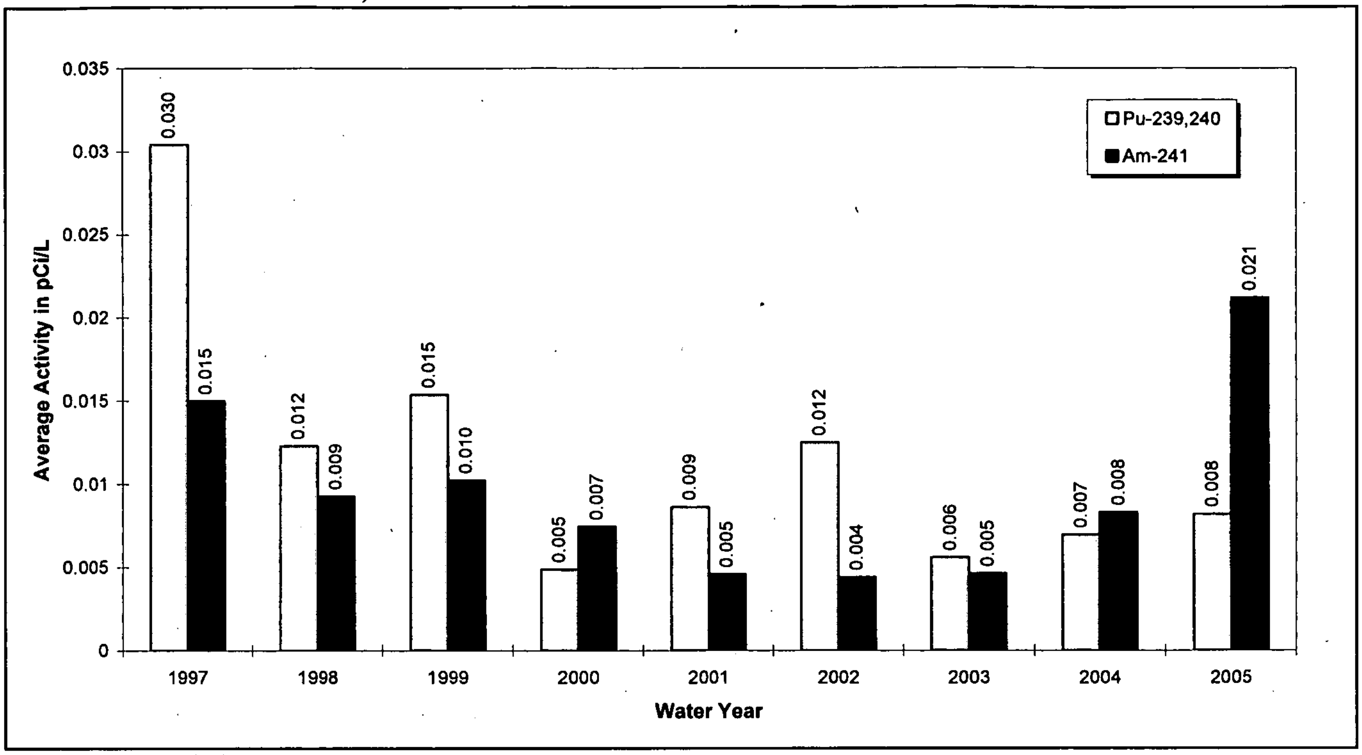
Note: Data through 7/27/05.

Figure 12-6. Volume-Weighted 30-Day Average Pu and Am Activities at GS03: WY97–05.



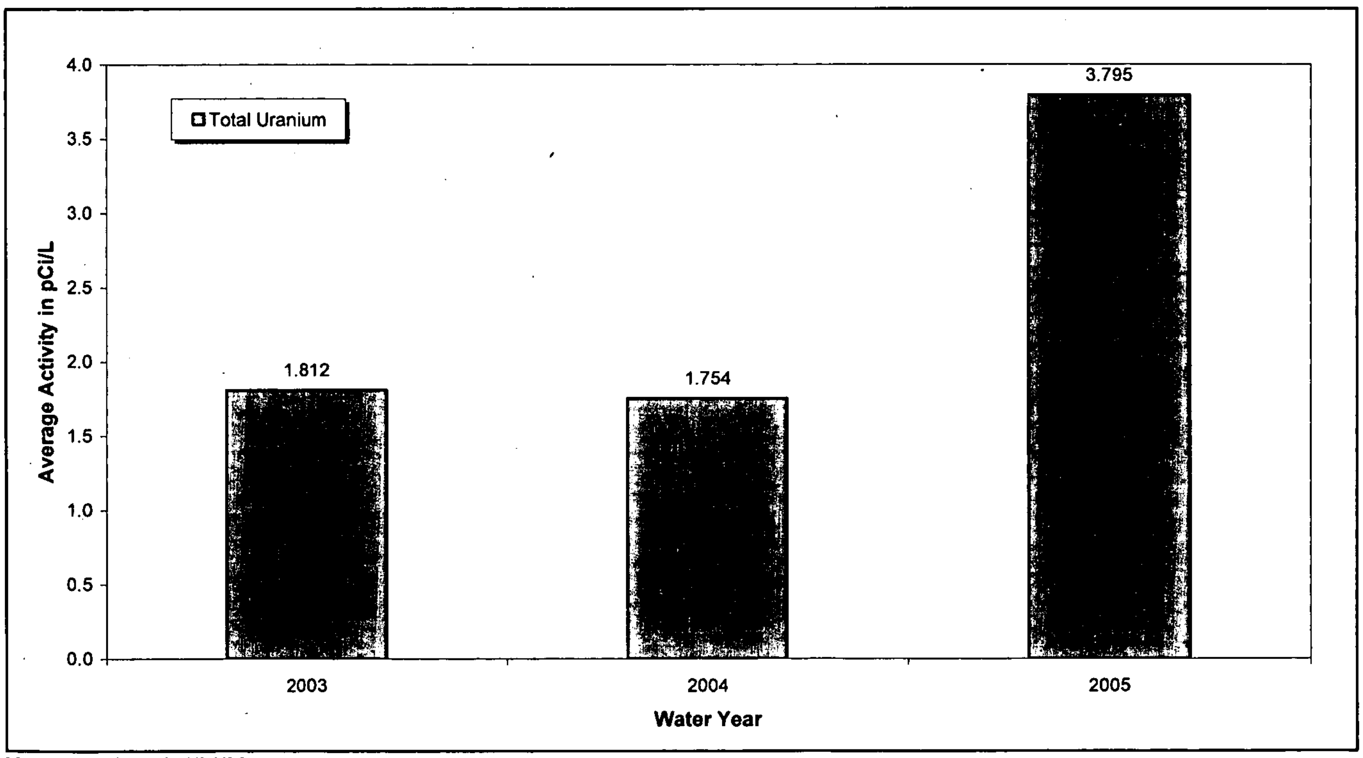
Note: Data through 7/27/05.

Figure 12-7. Volume-Weighted 30-Day Average Total Uranium Activities at GS03: WY03-05.



Note: Data through 7/27/05.

Figure 12-8. Annual Volume-Weighted Average Pu and Am Activities at GS03: WY97–05.



Note: Data through 7/27/05.

Figure 12-9. Annual Volume-Weighted Average Total Uranium Activities at GS03: WY03–05.

12.3.3 Location GS08

Monitoring location GS08 is located on South Walnut Creek at the outlet of Pond B-5. Figure 3-28 shows the drainage area for GS08. The central portion of the IA contributes flow to GS08.

Table 12-11 shows that all of the annual average Pu and Am activities were below the 0.15 pCi/L standard. Additionally, the long-term Pu and Am averages (WY97-05) are well below the 0.15 pCi/L standard. The average uranium activities are all well below the 10 pCi/L standard.

Figure 12-10 and Figure 12-11 show no occurrences of reportable 30-day averages.[65] However, between 9/14/00 and 11/24/00 five values of 0.15 pCi/L Pu were calculated. Although not required to perform a source evaluation, the Site did produce a report. The *Source Evaluation Report for RFCA Point of Compliance GS08: Water Years 2000-2001* (RMRS, 2001c) was completed in May 2001.

Figure 12-14 shows the rolling 12-month averages (see Appendix B.1: Data Evaluation Methods). It can be seen that by using this method the variability is 'dampened' by the longer evaluation period, and no values would be reportable at the 0.15 pCi/L standard.

Table 12-11. Annual Volume-Weighted Average Radionuclide Activities at GS08 in WY97-05.

Water Year	Volume-Weighted Average Activity (pCi/L)		
	Am-241	*Pu-239,240*	*Total Uranium*
1997	0.007	0.007	1.74
1998	0.007	0.008	2.26
1999	0.020	0.061	1.45
2000	0.025	0.041	1.00
2001	0.005	0.007	1.27
2002	0.003	0.003	0.751
2003	0.005	0.025	1.31
2004	0.010	0.008	1.23
2005	0.019	0.008	5.65
Total (WY97-05)	0.012	0.022	1.60

[65] A single Pu result collected at GS08 (7/11-7/17/03) did not meet the DER criteria of <1.5 (see Appendix B.1: Data Evaluation Methods). As such this Pu sample was not used in the calculation of the Pu 30-day or 365-day averages for GS08. The initial result was 0.787 pCi/L and the duplicate result was 0.001 pCi/L, for a DER of 4.0. The average of these results is used in all other evaluations.

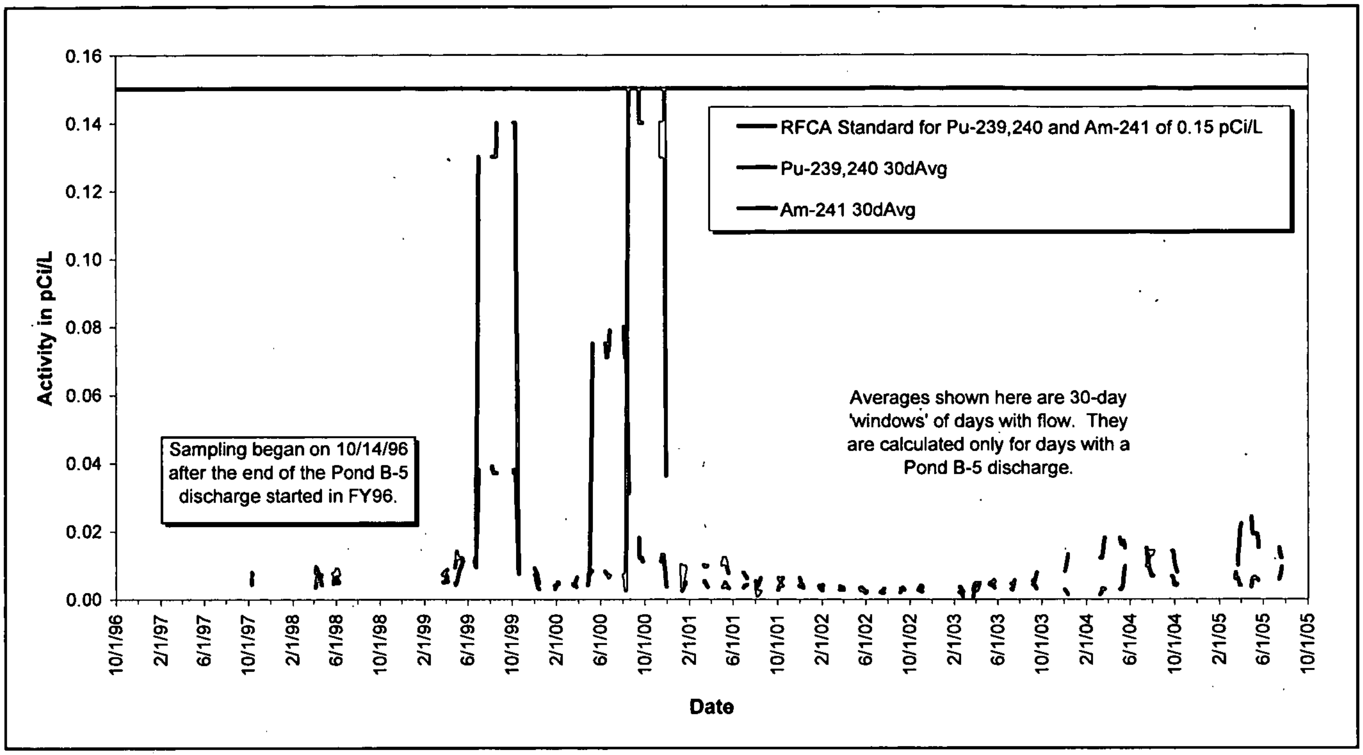


Figure 12-10. Volume-Weighted 30-Day Average Pu and Am Activities at GS08: WY97–05.

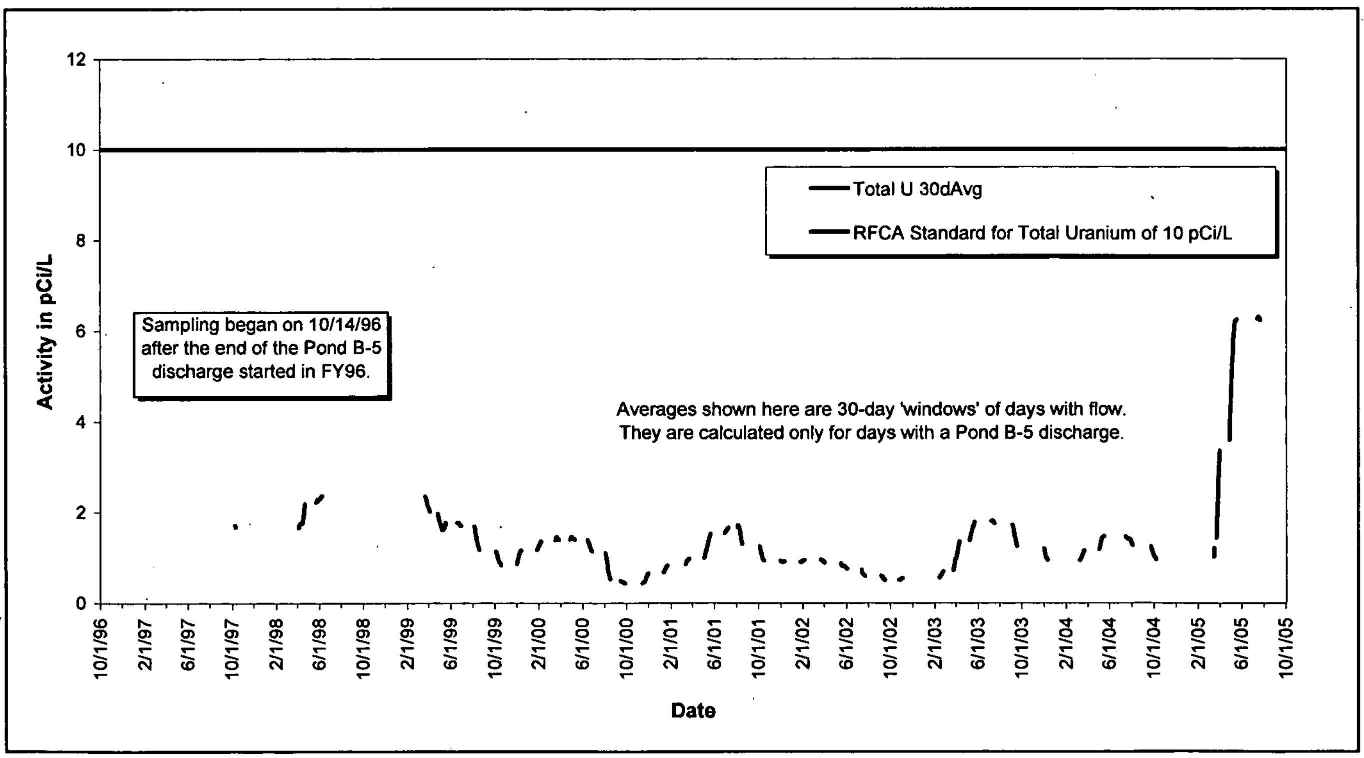


Figure 12-11. Volume-Weighted 30-Day Average Total Uranium Activities at GS08: WY97–05.

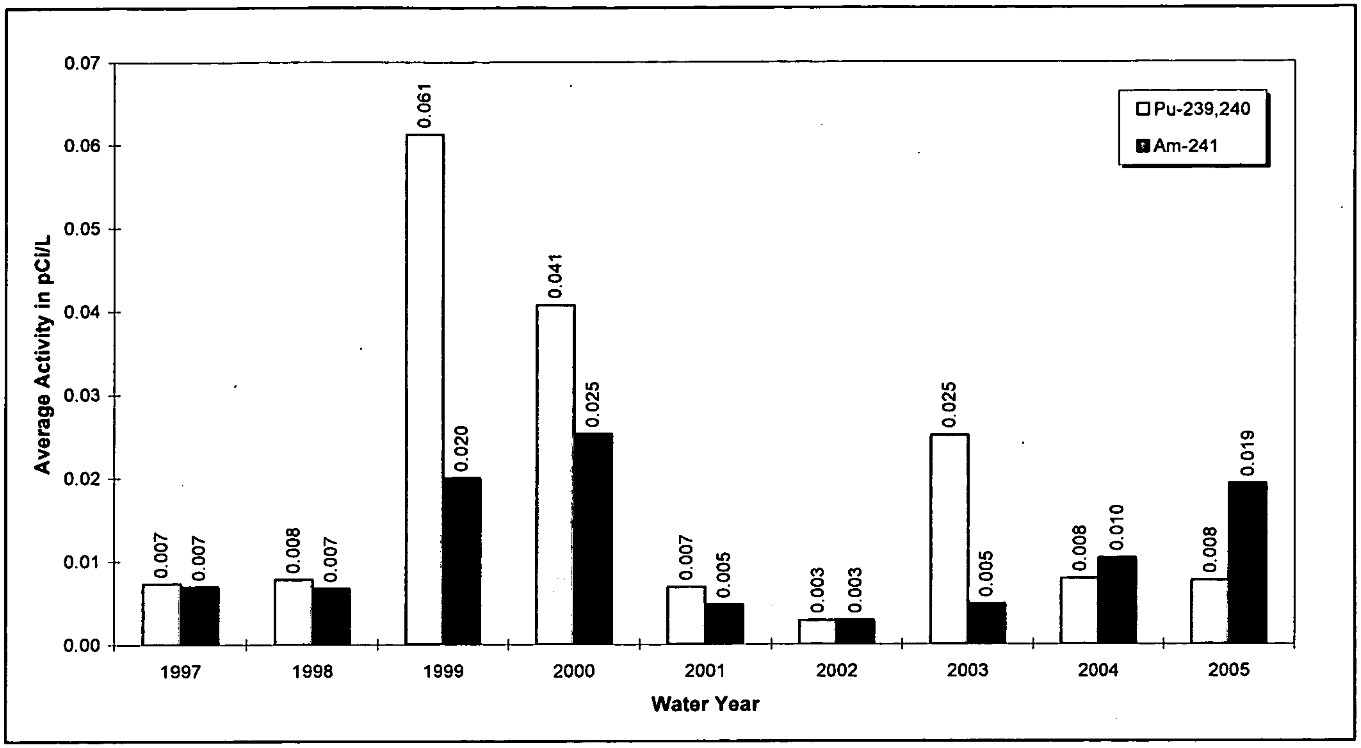


Figure 12-12. Annual Volume-Weighted Average Pu and Am Activities at GS08: WY97–05.

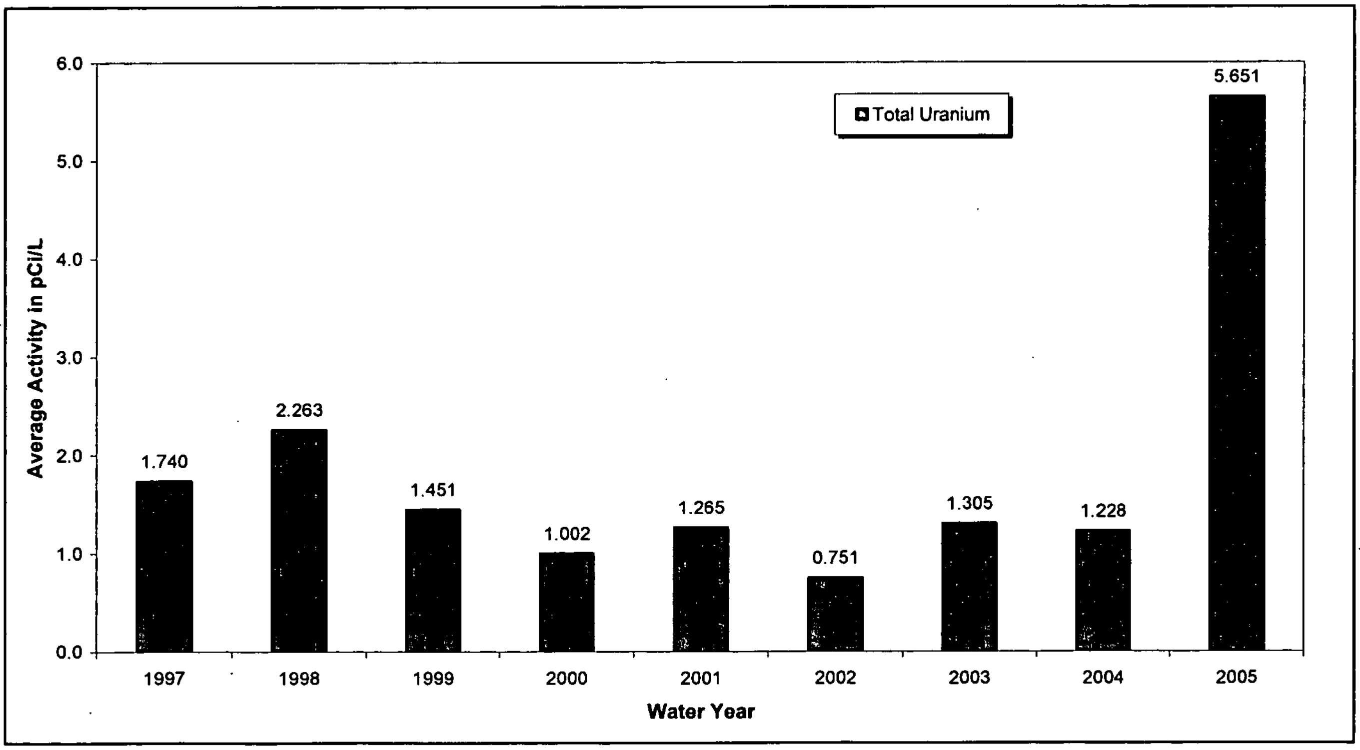
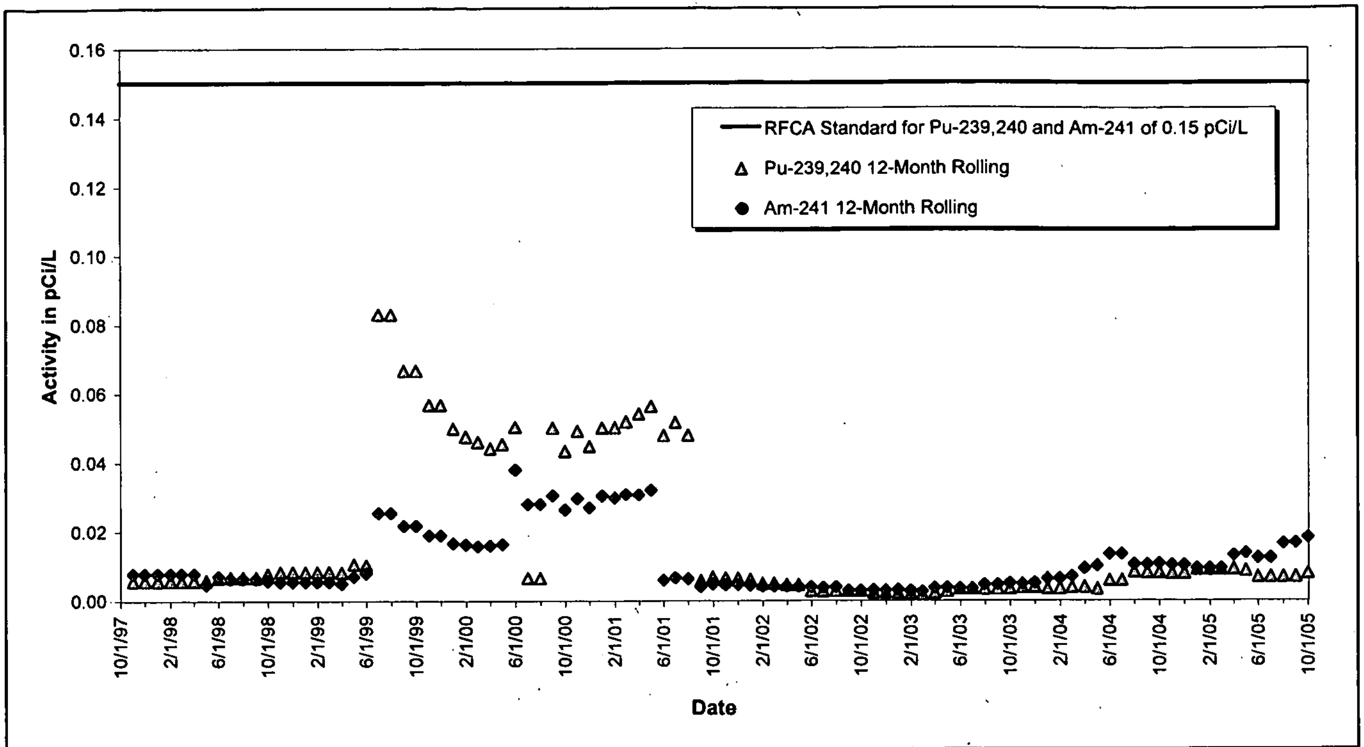
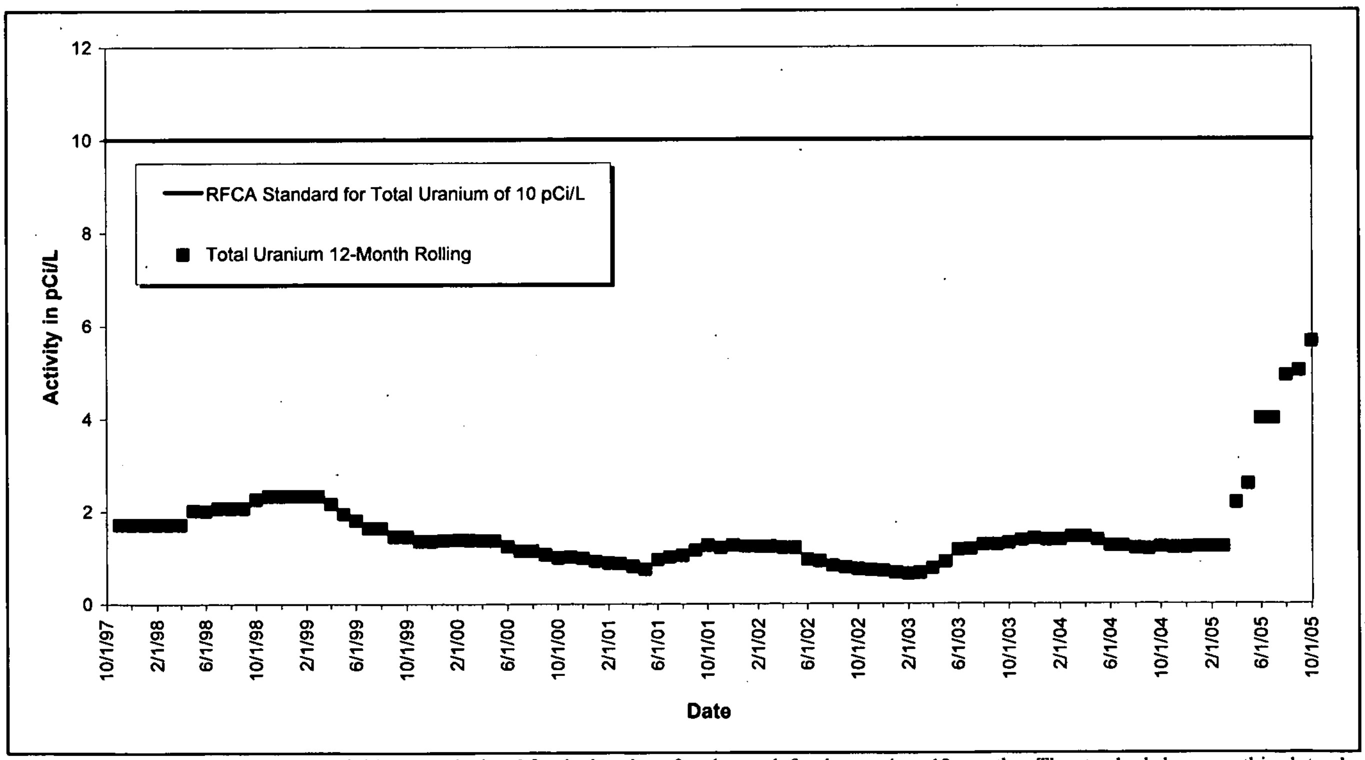


Figure 12-13. Annual Volume-Weighted Average Total Uranium Activities at GS08: WY97–05.



Note: The rolling 12-month average activities are calculated for the last day of each month for the previous 12 months. The standard shown on this plot only applies to 30-day averages. It is shown here for reference only.

Figure 12-14. Rolling 12-Month Average Pu and Am Activities at GS08: WY98–05.



Note: The rolling 12-month average activities are calculated for the last day of each month for the previous 12 months. The standard shown on this plot only applies to 30-day averages. It is shown here for reference only.

Figure 12-15. Rolling 12-Month Average Total Uranium Activities at GS08: WY98–05.

Mean daily water-quality parameter data are plotted in Figure 12-16 through Figure 12-23 along with the mean daily flow rate. Figure 12-16 and Figure 12-17 show the expected annual variation in water temperature.

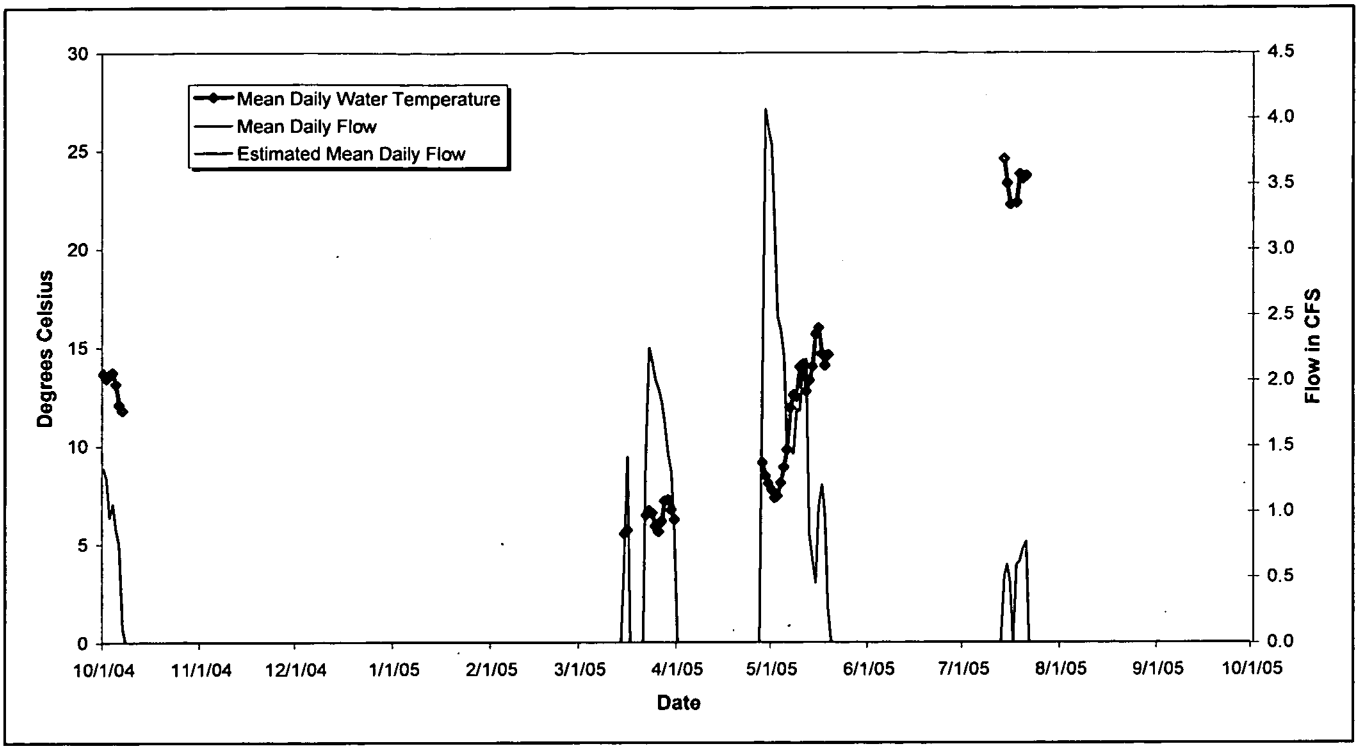


Figure 12-16. Mean Daily Water Temperature at GS08: WY05.

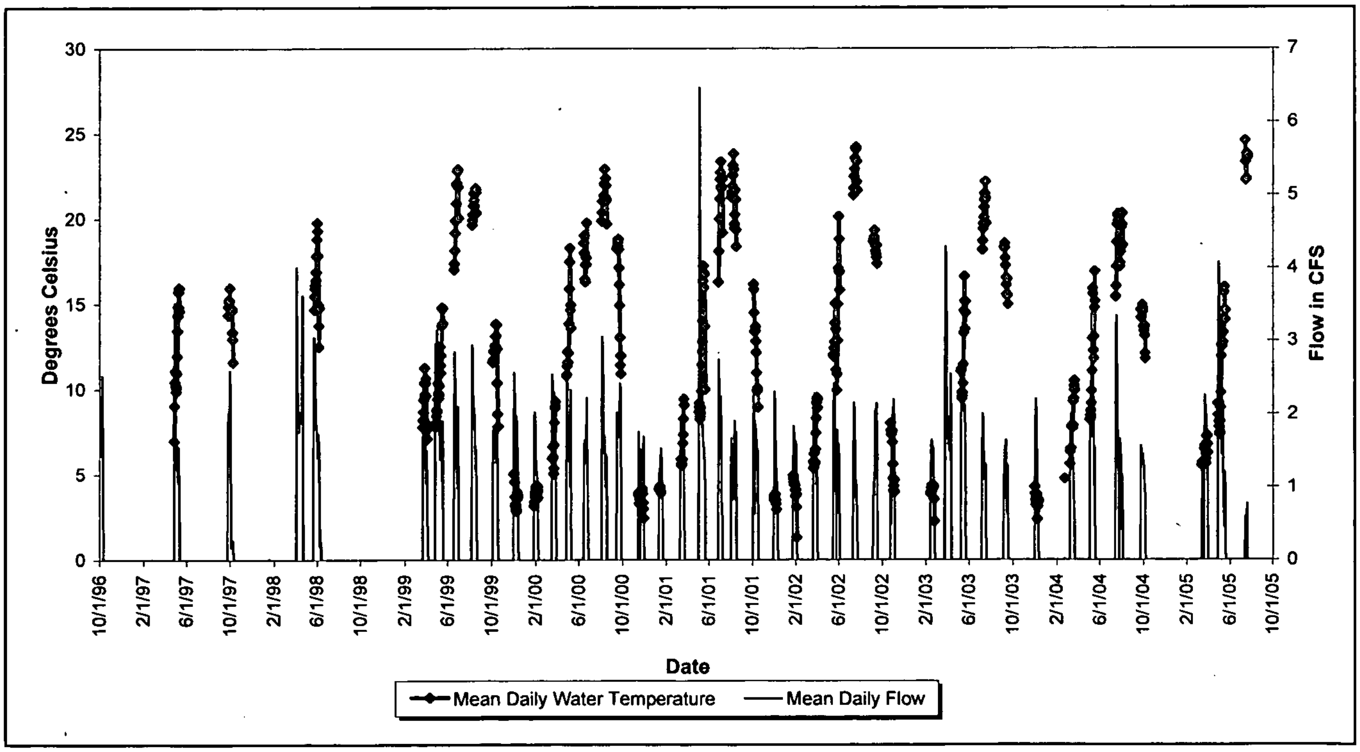


Figure 12-17. Mean Daily Water Temperature at GS08: WY97-05.

Figure 12-18 and Figure 12-19 show elevated conductivities during the winter months, most likely a result of road and walkway deicing operations. The effects of changes in deicing products (magnesium chloride) starting in WY00 can be seen in Figure 12-19.

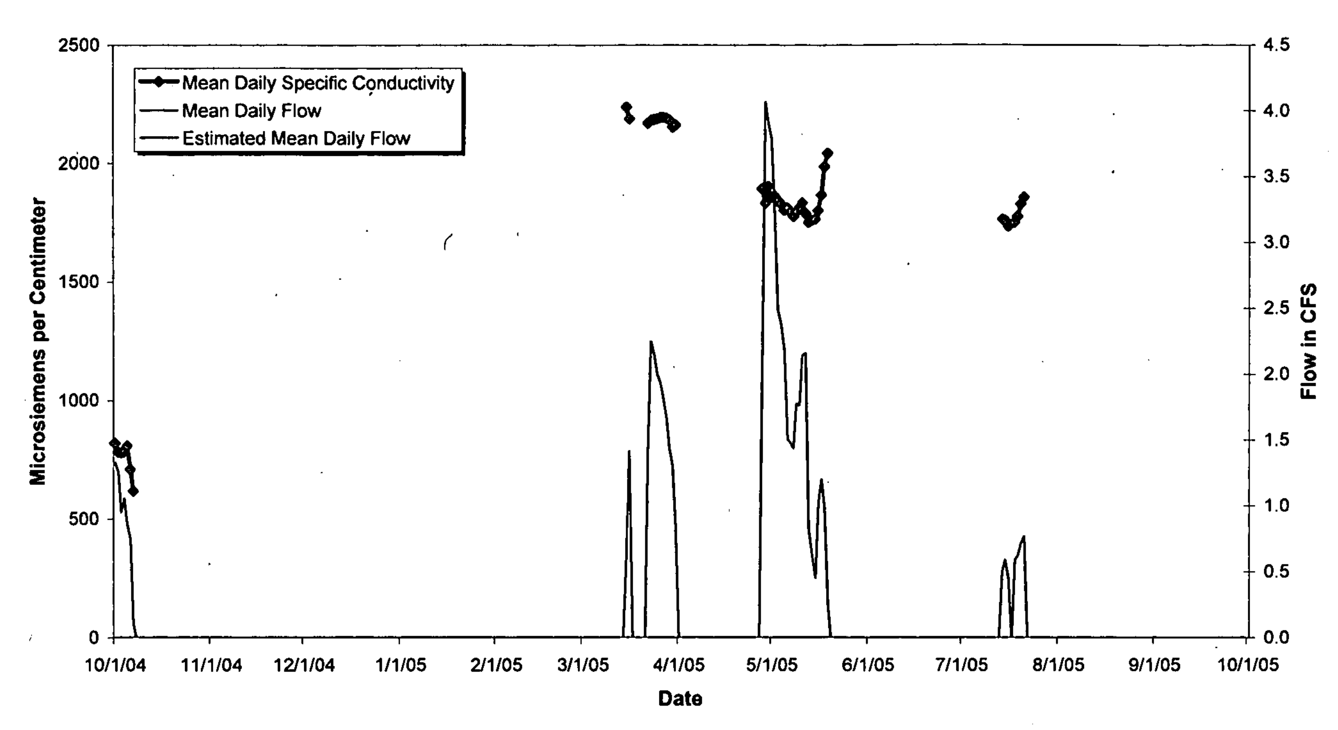


Figure 12-18. Mean Daily Specific Conductivity at GS08: WY05.

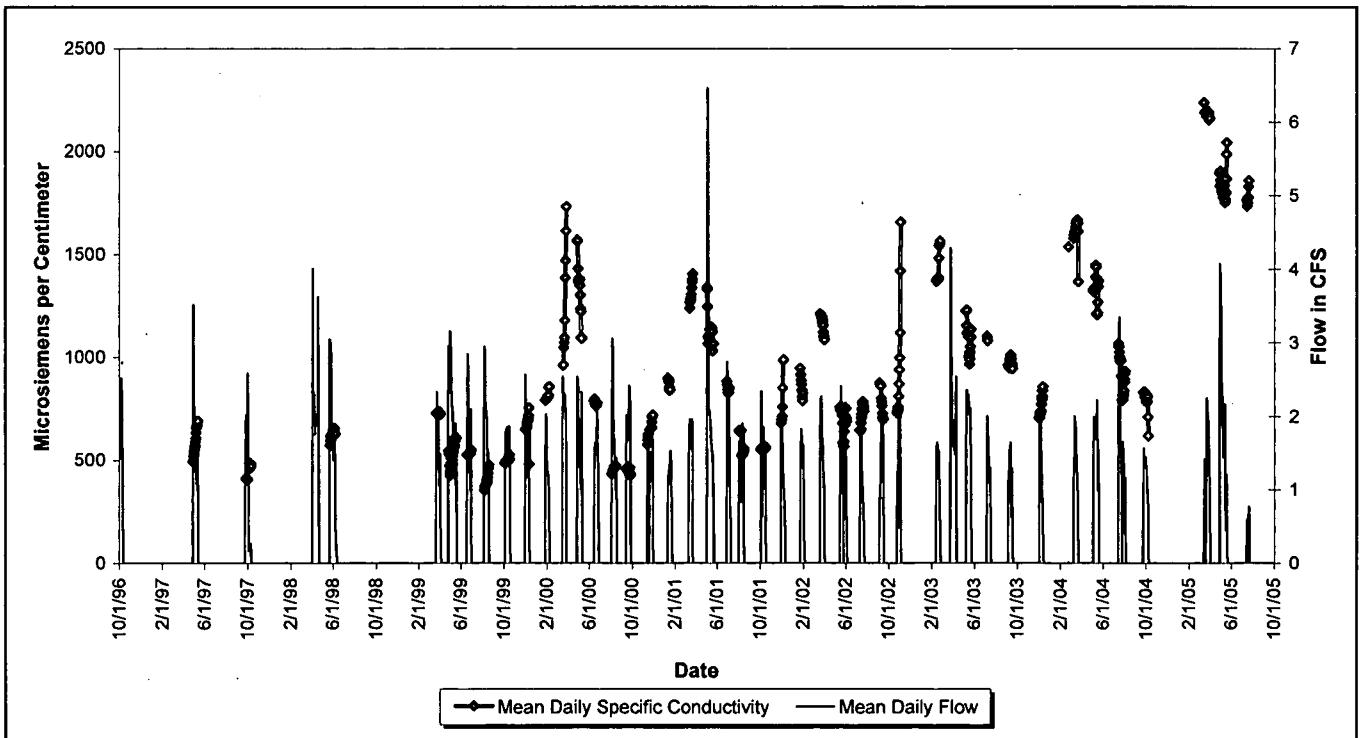


Figure 12-19. Mean Daily Specific Conductivity at GS08: WY97-05.

Figure 12-20 and Figure 12-21 show the mean daily pH varying between 7.0 and 10.7. The somewhat higher pH values are likely due to algae growth affecting the carbon dioxide buffering capacity.

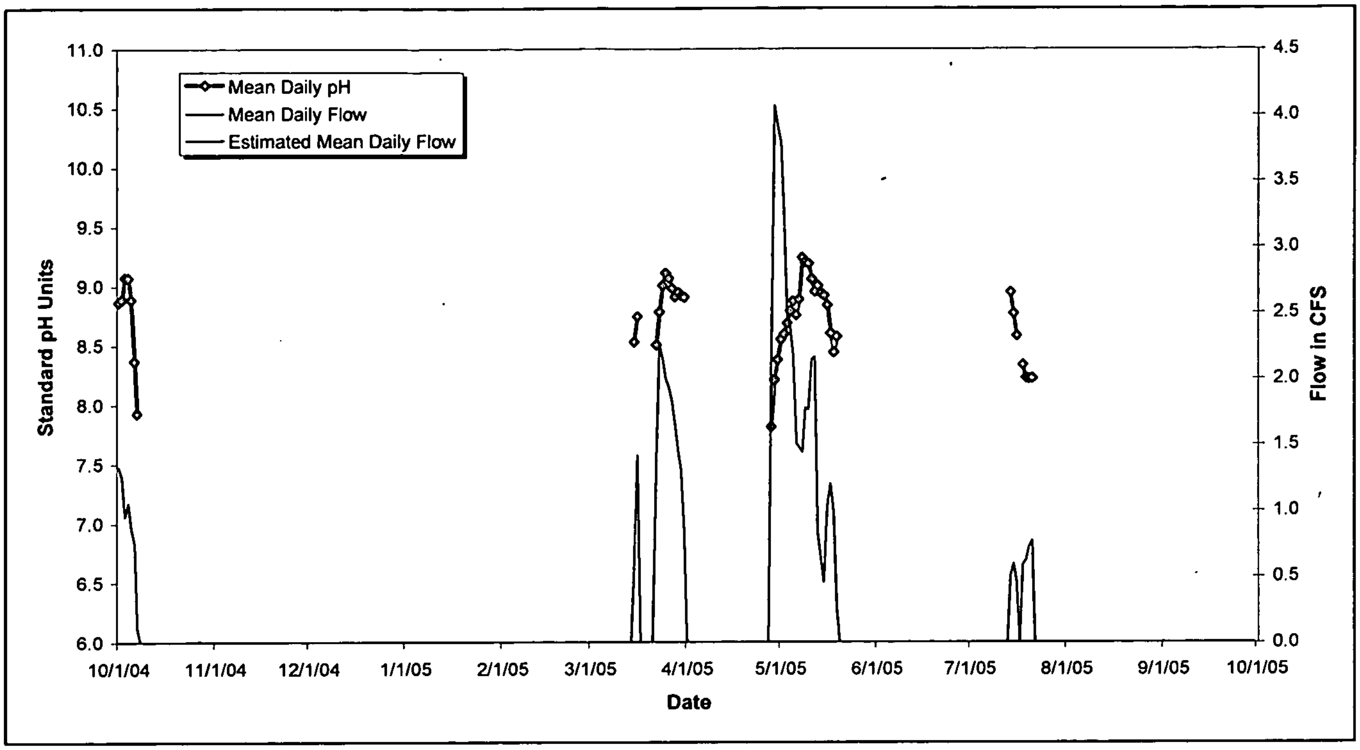


Figure 12-20. Mean Daily pH at GS08: WY05.

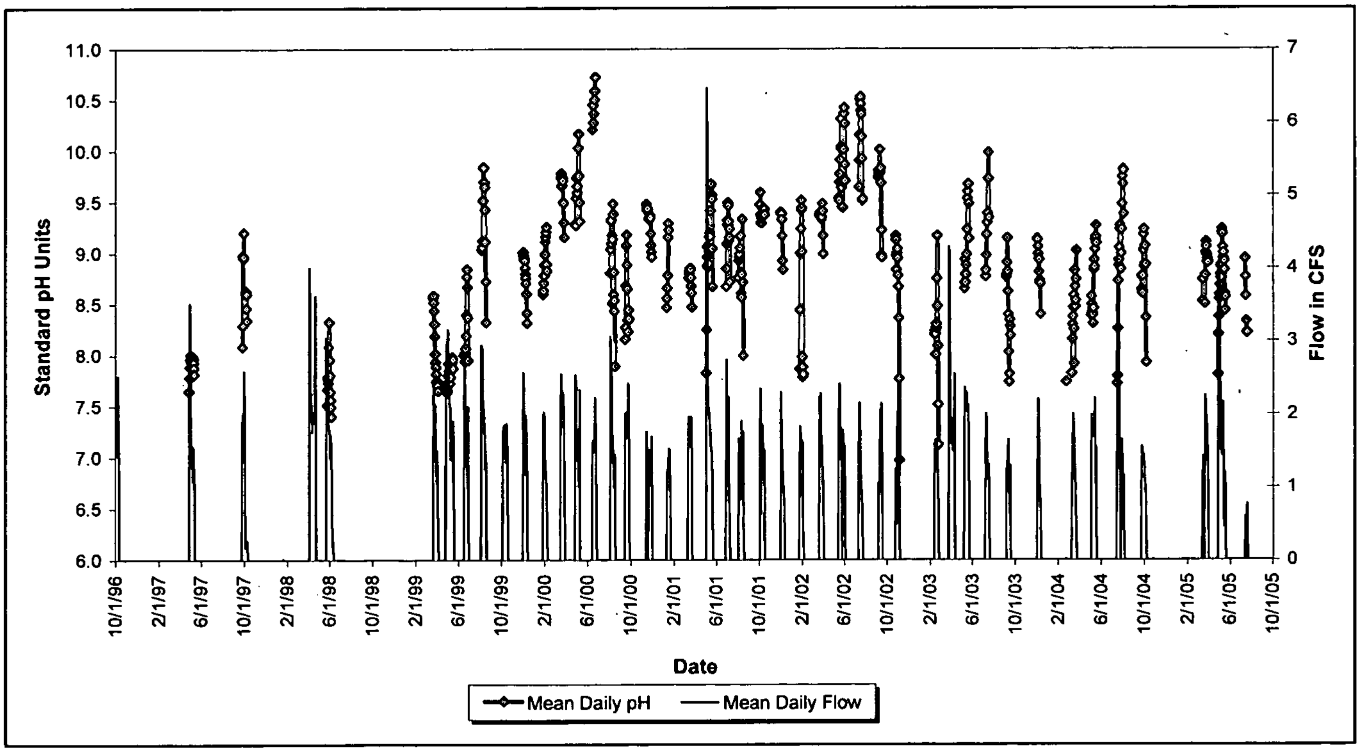


Figure 12-21. Mean Daily pH at GS08: WY97-05.

Finally, Figure 12-22 and Figure 12-23 show variable turbidity measurements. These variations are likely the result of biological growth in the pond and/or turbidity from recent pond inflows.

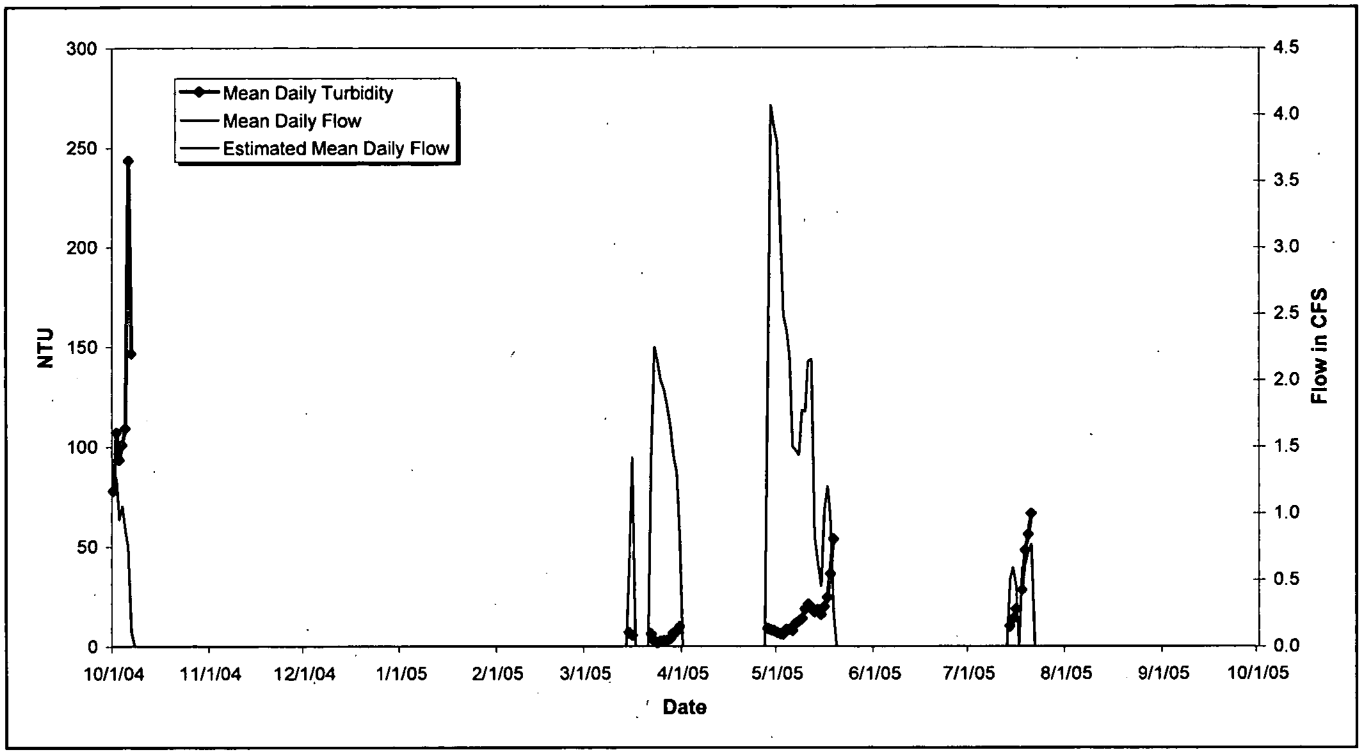


Figure 12-22. Mean Daily Turbidity at GS08: WY05.

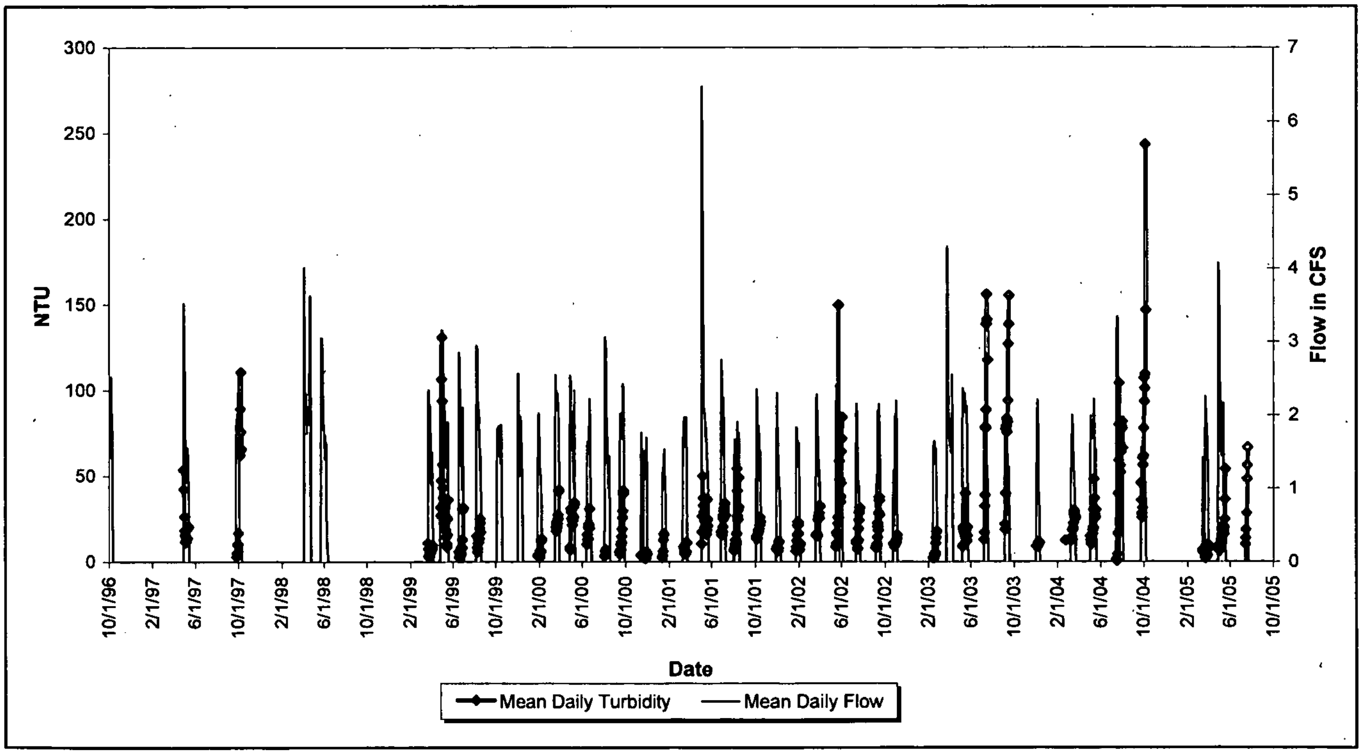


Figure 12-23. Mean Daily Turbidity at GS08: WY97-05.

12.3.4 Location GS11

Monitoring location GS11 is located on North Walnut Creek at the outlet of Pond A-4. Figure 3-34 shows the drainage area for GS11. The northern portion of the IA contributes flow to GS11.

Table 12-12 shows that all of the annual average Pu and Am activities were well below the 0.15 pCi/L standard. Additionally, the long-term Pu and Am averages (WY97-05) are well below the 0.15 pCi/L standard. The average uranium activities are all well below the 10 pCi/L standard.

Figure 12-24 and Figure 12-25 show no occurrences of reportable 30-day averages.

Figure 12-28 shows the rolling 12-month averages (see Appendix B.1: Data Evaluation Methods). It can be seen that by using this method the variability is 'dampened' by the longer evaluation period, and no values would be reportable at the 0.15 pCi/L standard.

Table 12-12. Annual Volume-Weighted Average Radionuclide Activities at GS11 in WY97-05.

Water Year	Volume-Weighted Average Activity (pCi/L)		
	Am-241	*Pu-239,240*	*Total Uranium*
1997	0.005	0.009	1.89
1998	0.009	0.004	2.07
1999	0.004	0.006	1.74
2000	0.001	0.029	3.23
2001	0.002	0.002	2.49
2002	0.003	0.000	2.96
2003	0.003	0.002	2.88
2004	0.005	0.003	2.56
2005	0.022	0.002	1.78
Total (WY97-05)	0.006	0.006	2.19

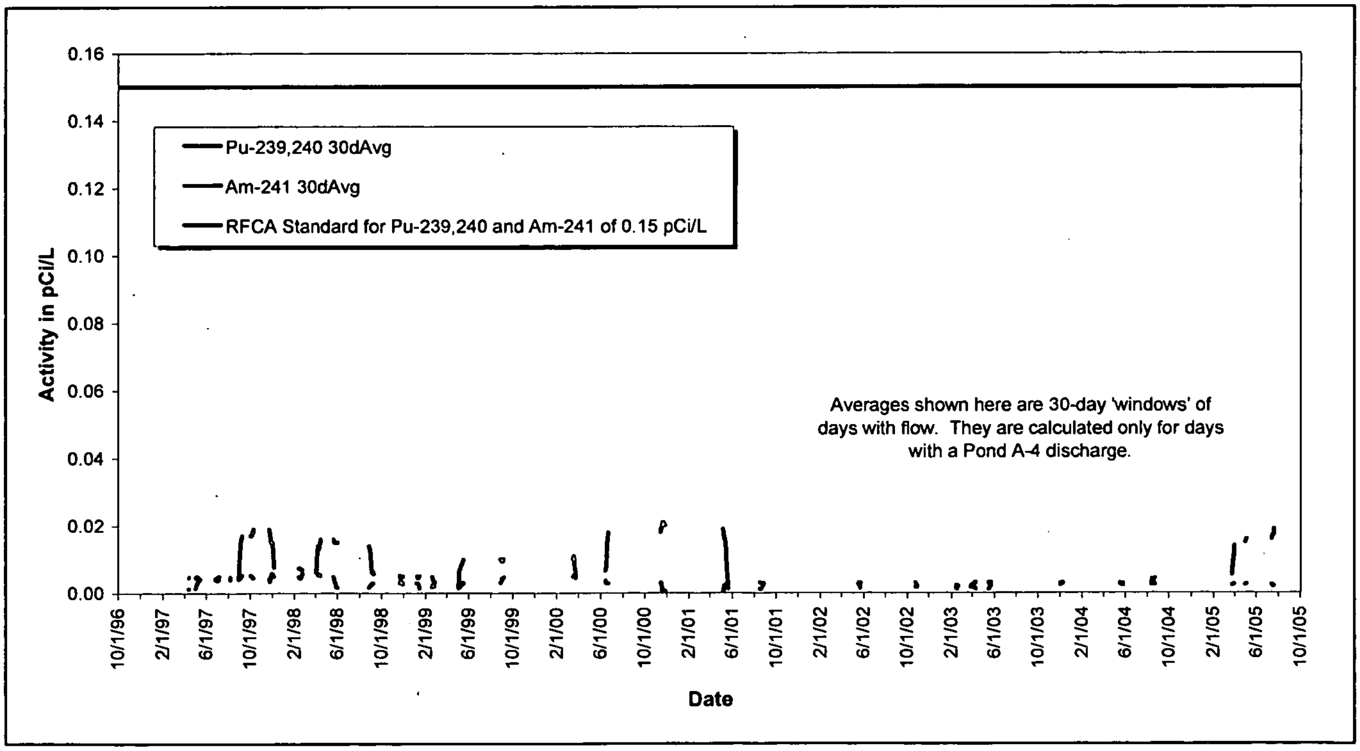


Figure 12-24. Volume-Weighted 30-Day Average Pu and Am Activities at GS11: WY97–05.

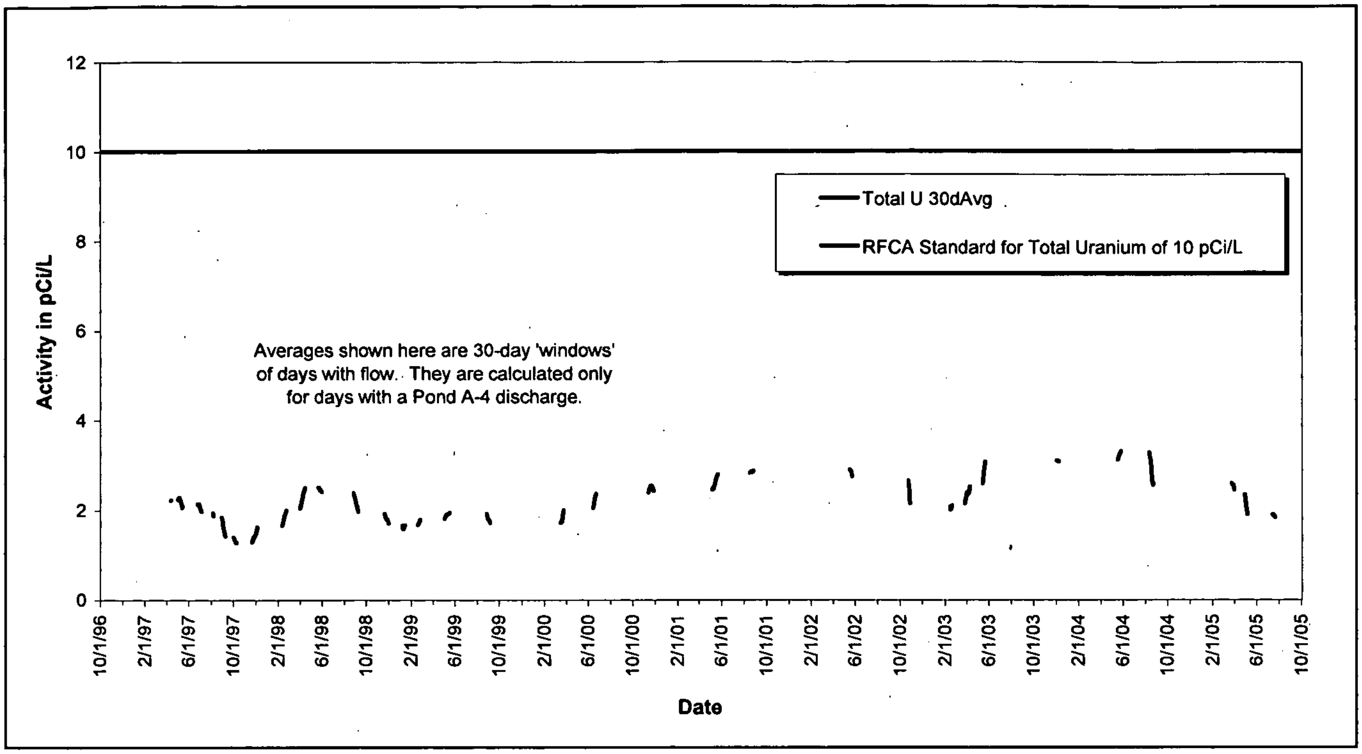


Figure 12-25. Volume-Weighted 30-Day Average Total Uranium Activities at GS11: WY97–05.

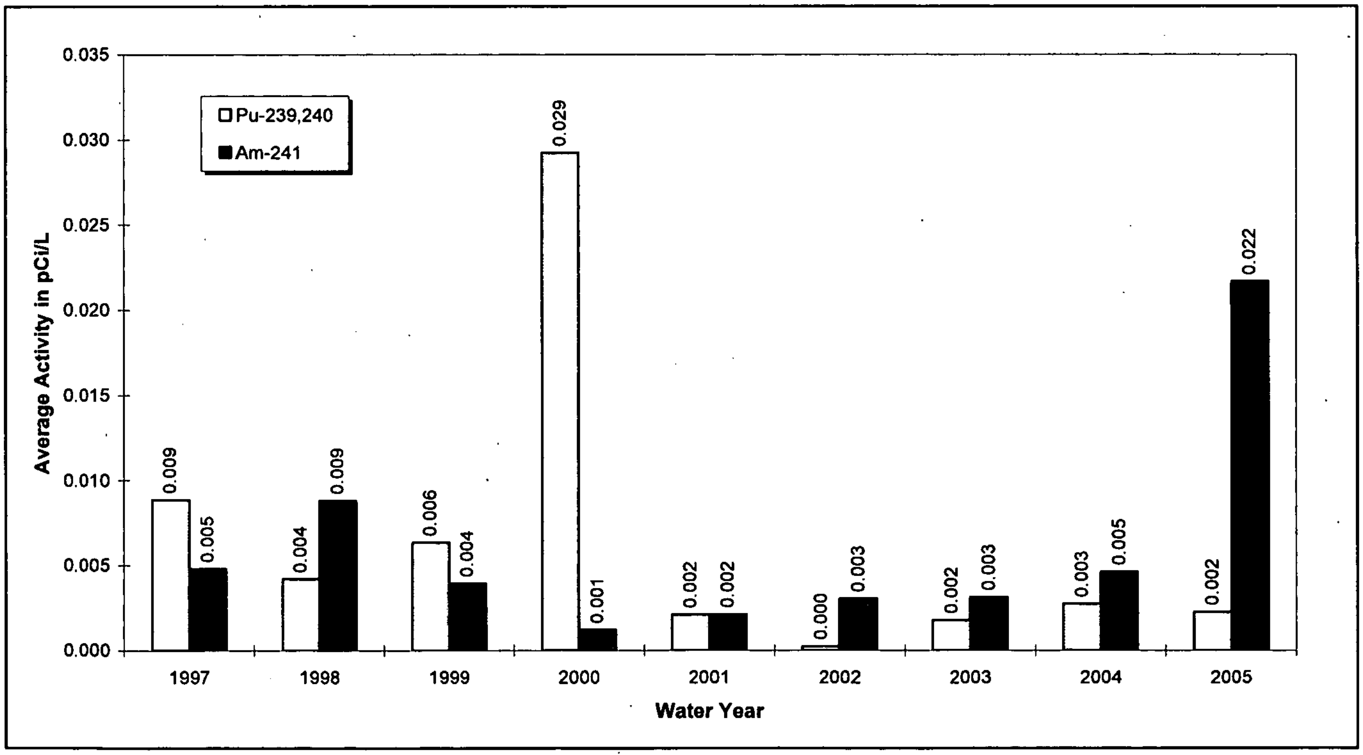


Figure 12-26. Annual Volume-Weighted Average Pu and Am Activities at GS11: WY97–05.

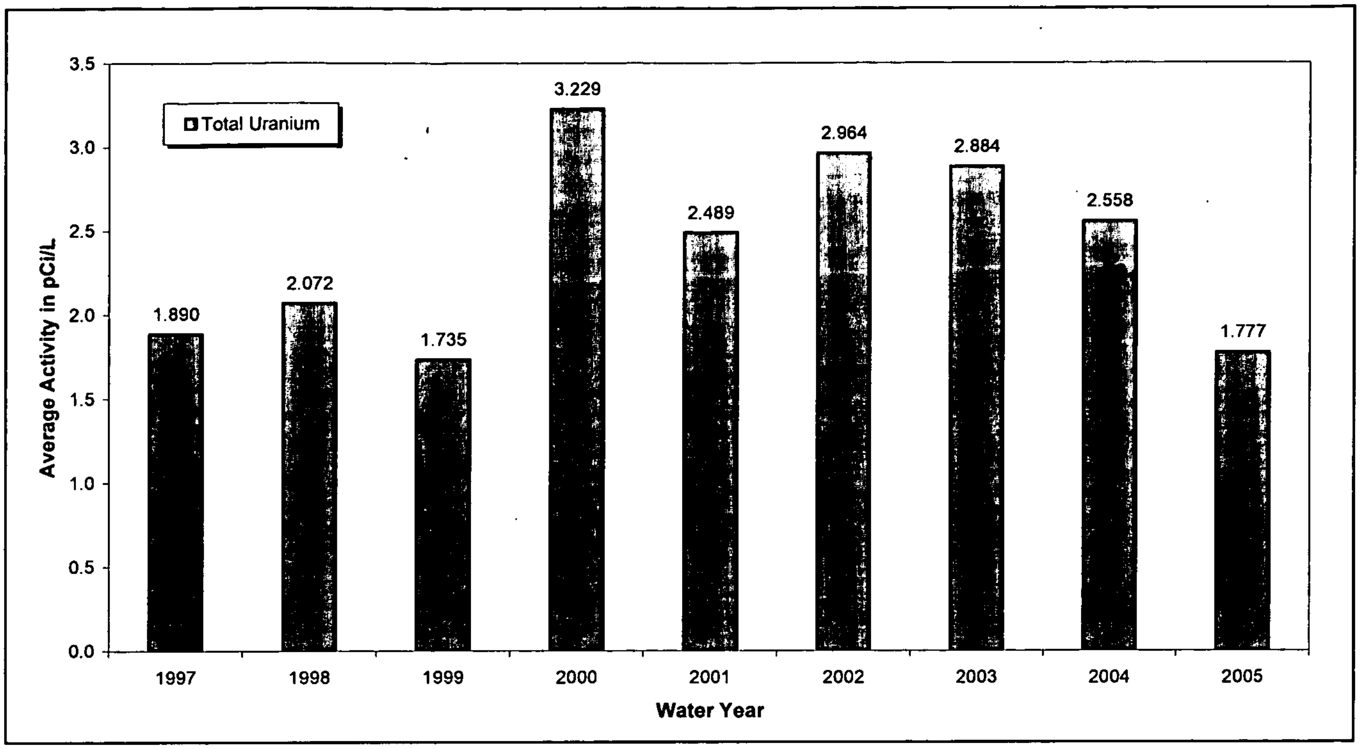
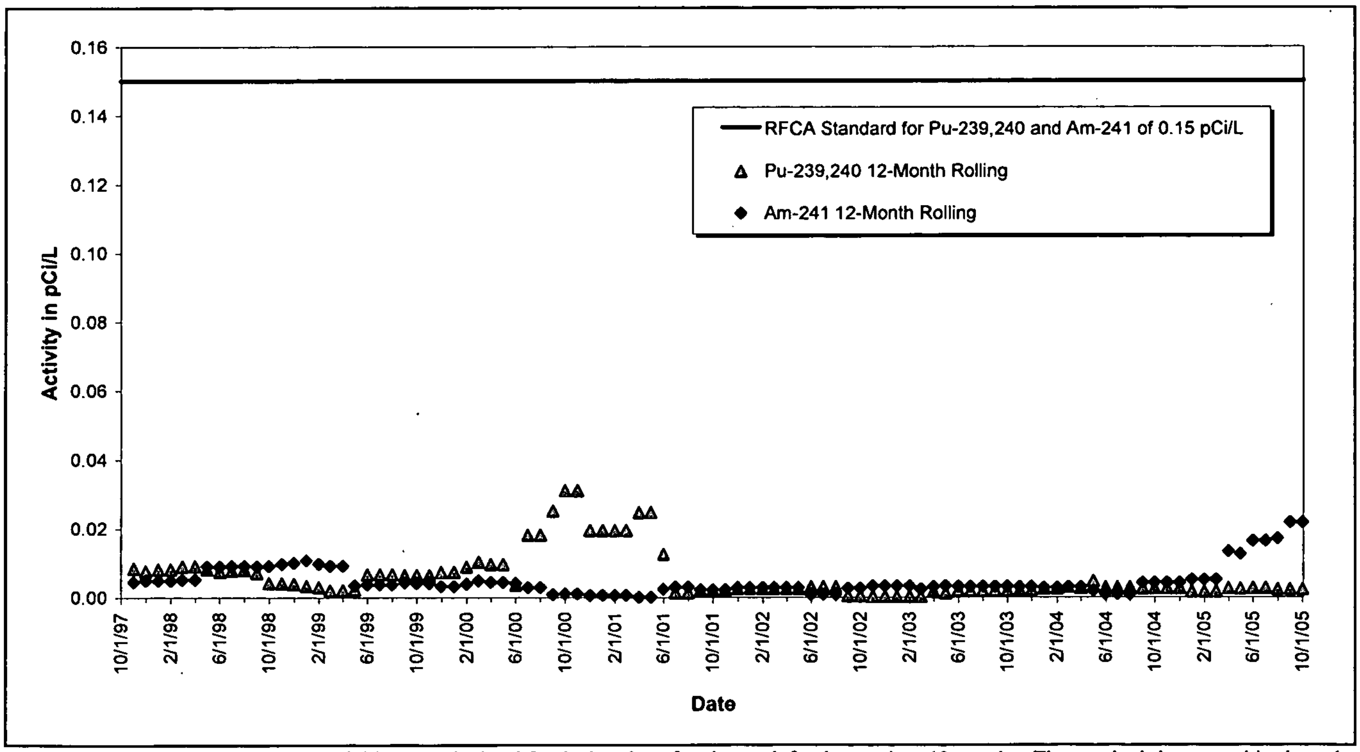
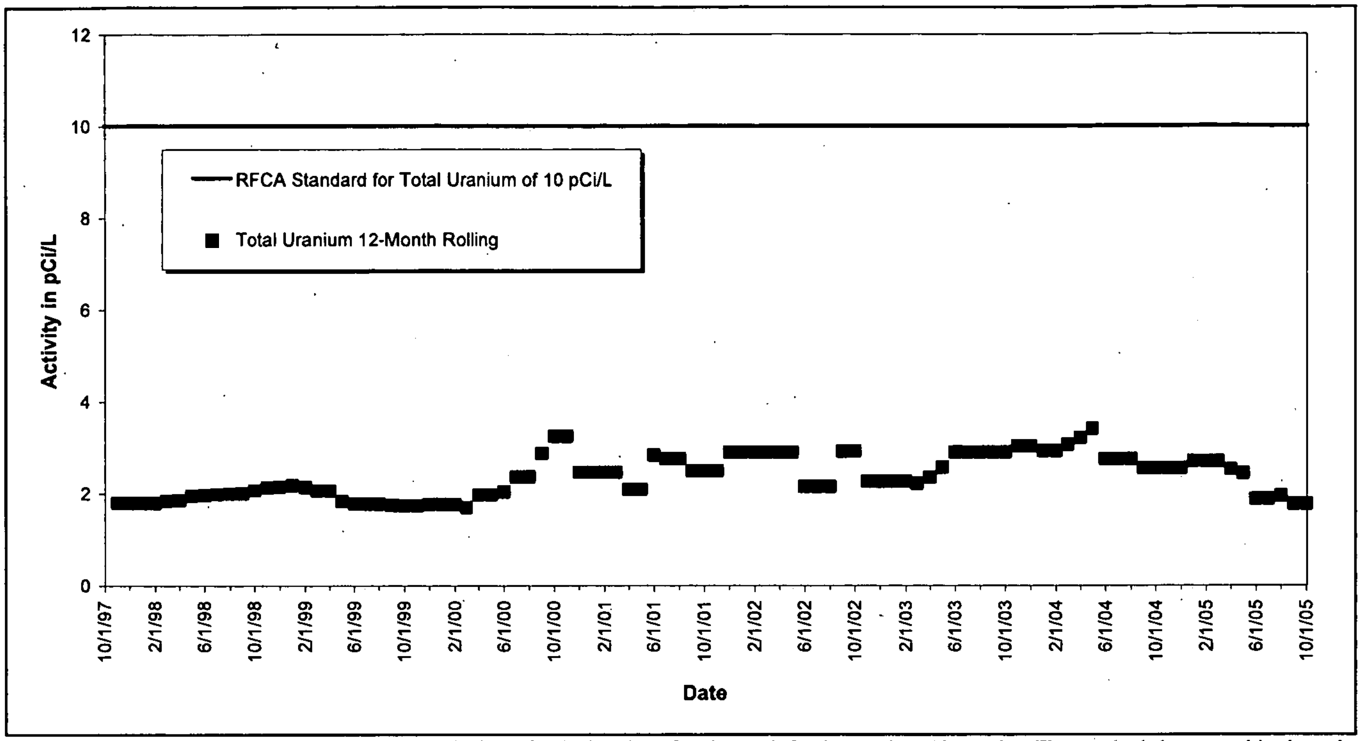


Figure 12-27. Annual Volume-Weighted Average Total Uranium Activities at GS11: WY97–05.



Note: The rolling 12-month average activities are calculated for the last day of each month for the previous 12 months. The standard shown on this plot only applies to 30-day averages. It is shown here for reference only.

Figure 12-28. Rolling 12-Month Average Pu and Am Activities at GS11: WY98–05.



Note: The rolling 12-month average activities are calculated for the last day of each month for the previous 12 months. The standard shown on this plot only applies to 30-day averages. It is shown here for reference only.

Figure 12-29. Rolling 12-Month Average Total Uranium Activities at GS11: WY98–05.

Mean daily water-quality parameter data are plotted in Figure 12-30 through Figure 12-37 along with the mean daily flow rate. Figure 12-30 and Figure 12-31 show the expected annual variation in water temperature.

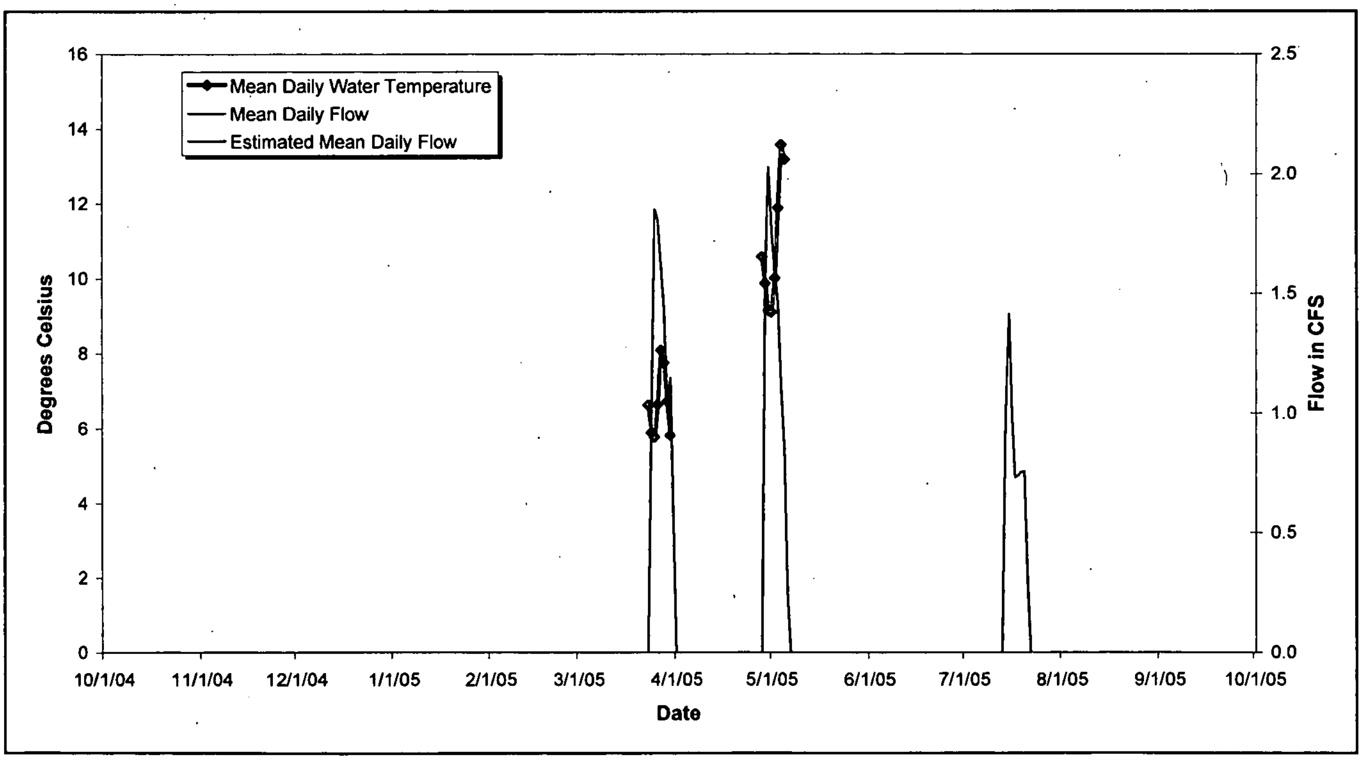


Figure 12-30. Mean Daily Water Temperature at GS11: WY05.

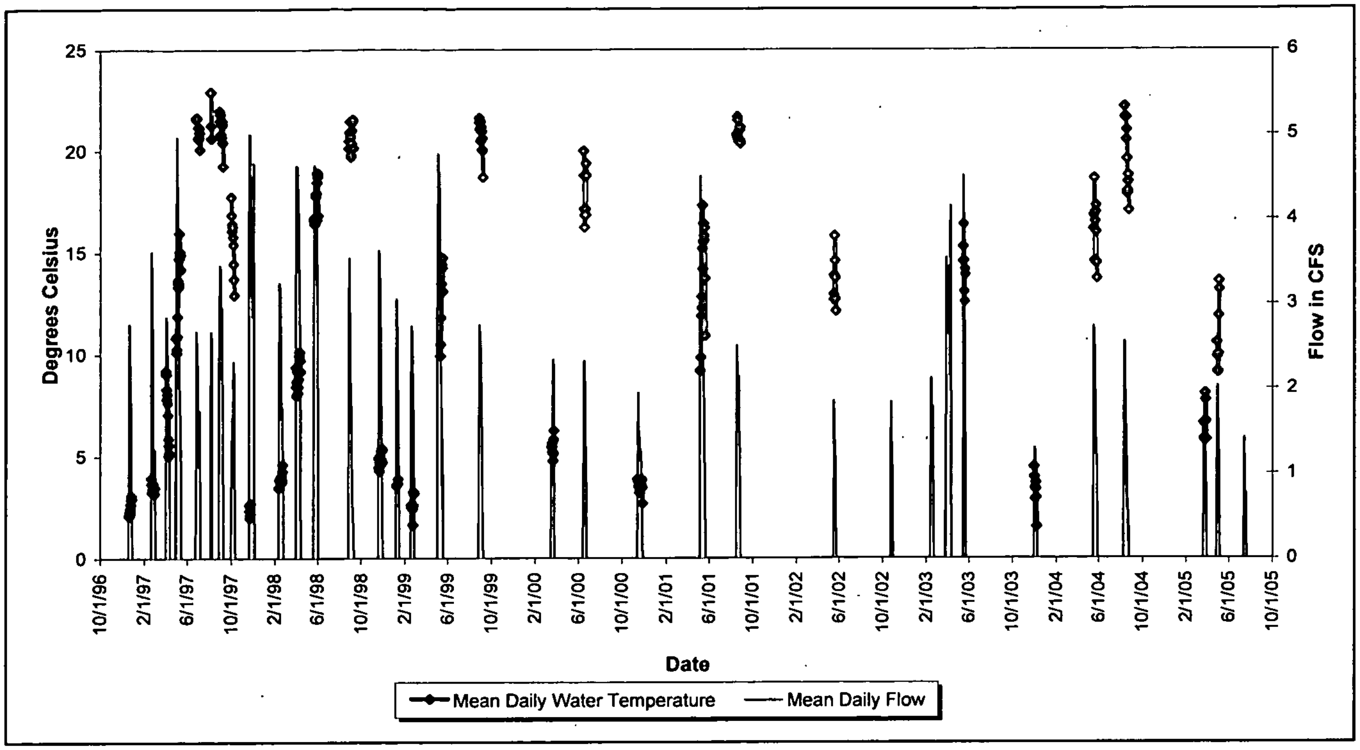


Figure 12-31. Mean Daily Water Temperature at GS11: WY97-05.

Figure 12-32 and Figure 12-33 show elevated conductivities, most likely a result of road and walkway deicing operations. The effects of changes in deicing products (magnesium chloride) starting in WY00 can be seen in Figure 12-33. The higher May 2001 conductivities are likely caused by runoff that entered A-4 during previous winter months.

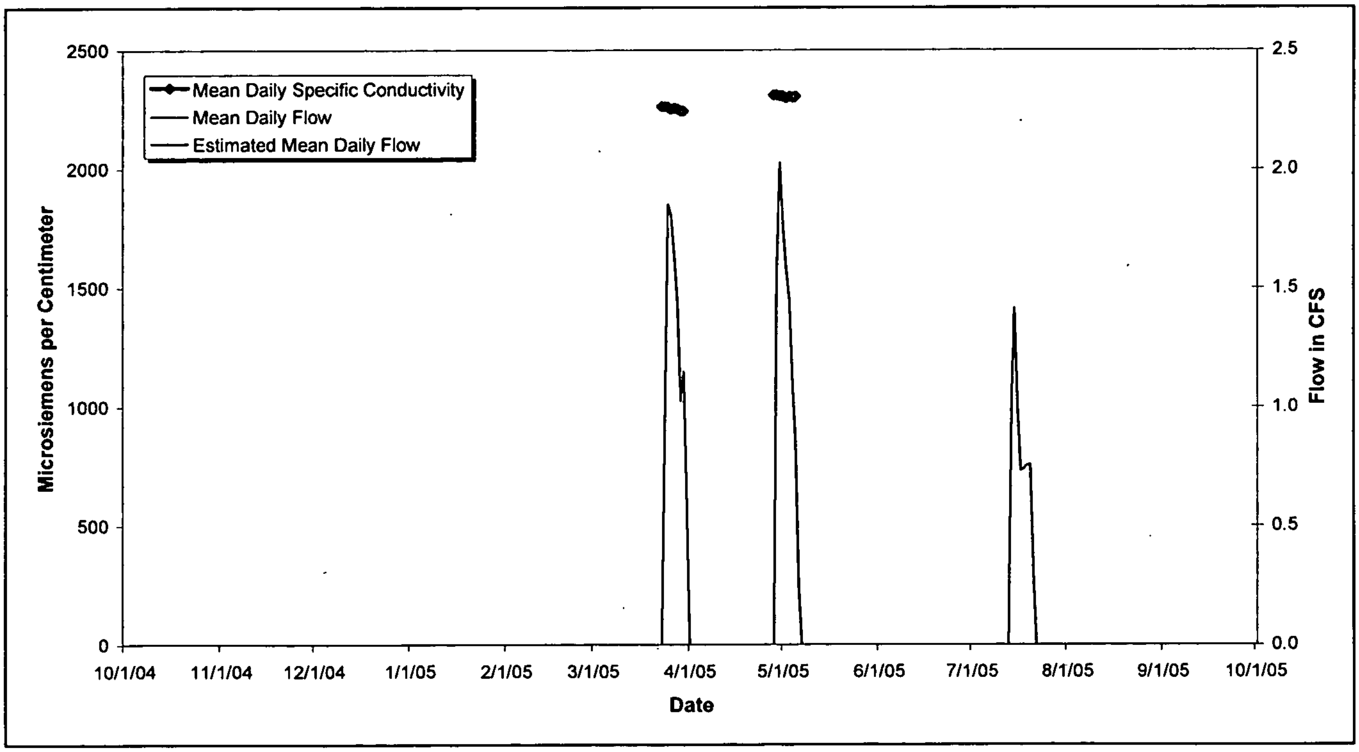


Figure 12-32. Mean Daily Specific Conductivity at GS11: WY05.

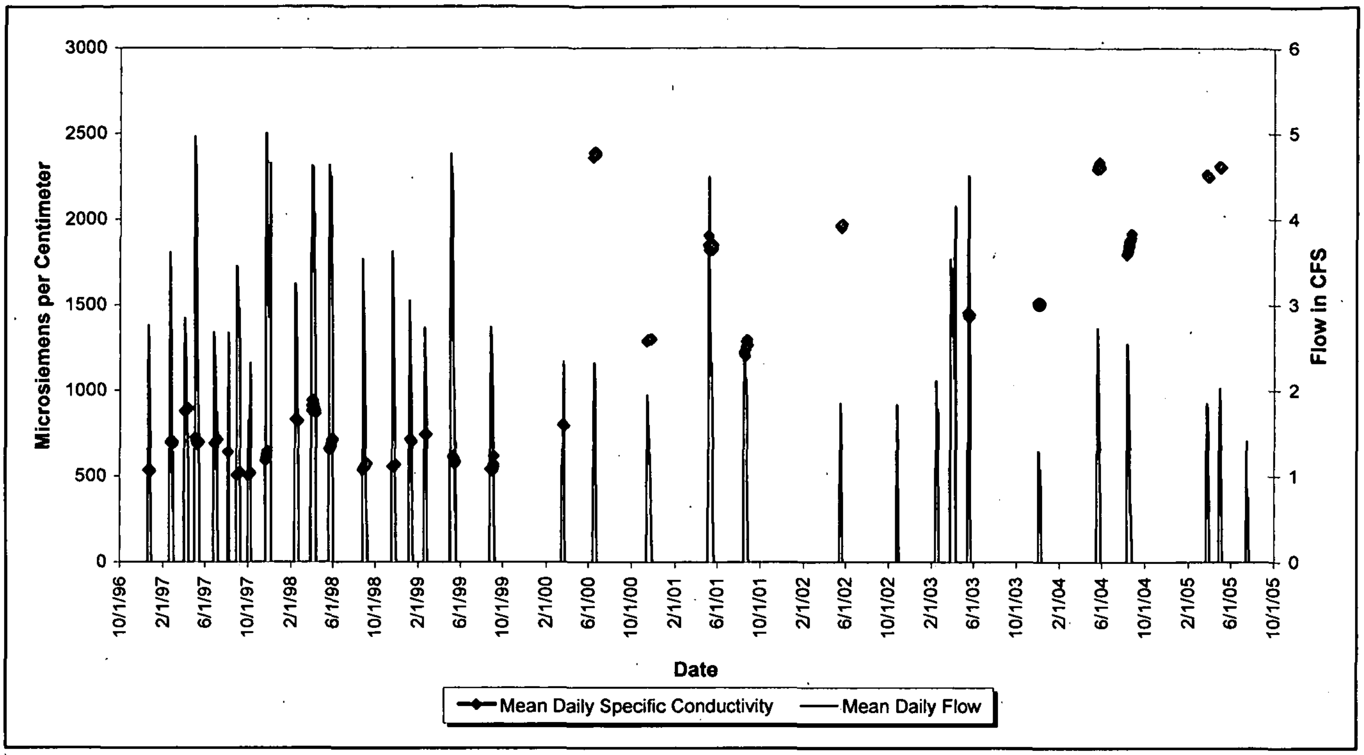


Figure 12-33. Mean Daily Specific Conductivity at GS11: WY97-05.

Figure 12-34 and Figure 12-35 show the mean daily pH varying between 7.4 and 10.4. The somewhat higher pH values are likely due to algae growth affecting the carbon dioxide buffering capacity.

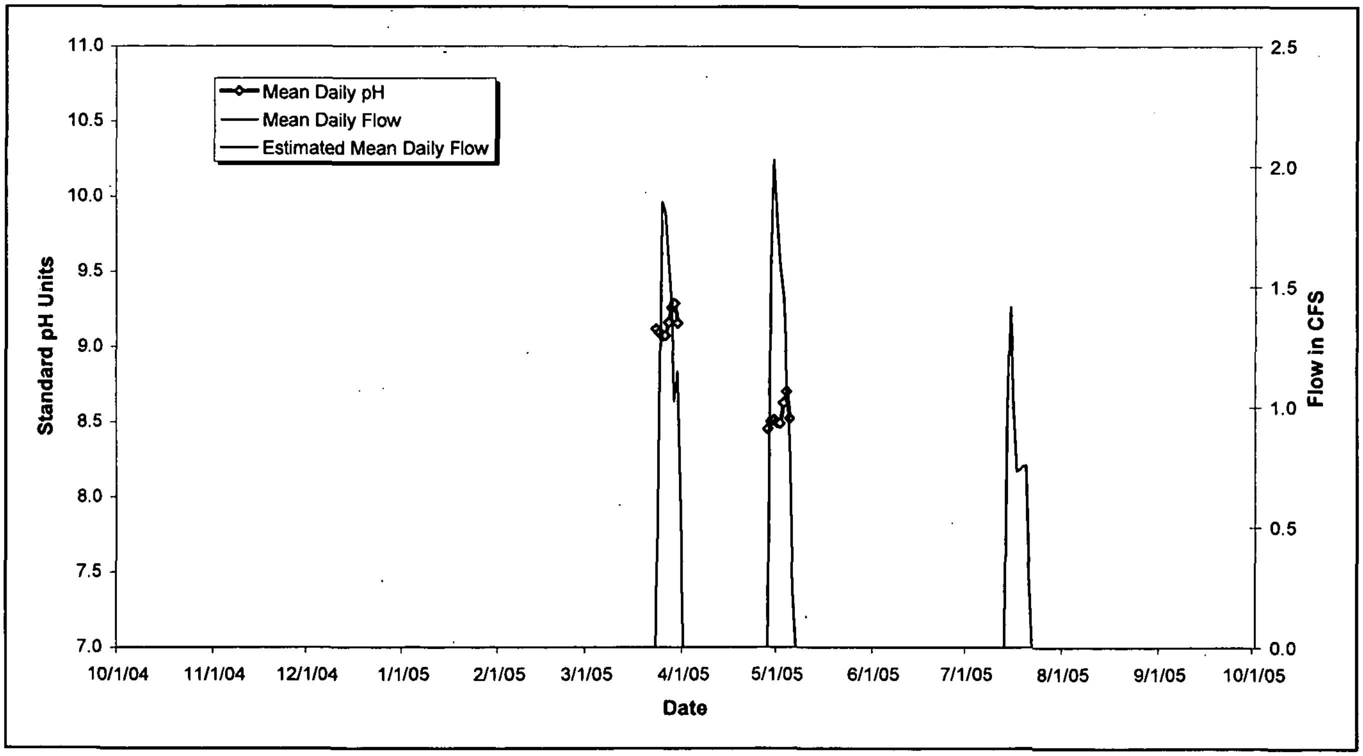


Figure 12-34. Mean Daily pH at GS11: WY05.

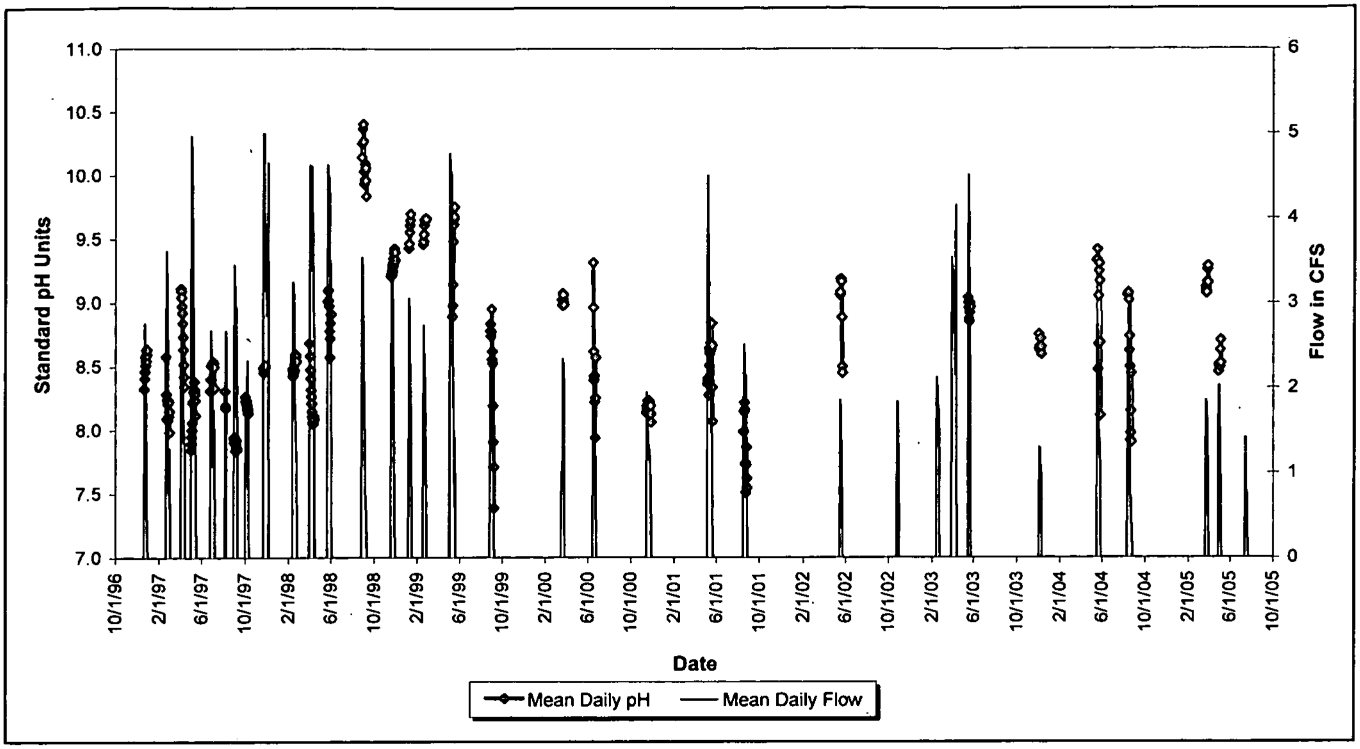


Figure 12-35. Mean Daily pH at GS11: WY97-05.

Finally, Figure 12-36 and Figure 12-37 show variable turbidity measurements. These variations are likely the result of biological growth in the pond and turbidity from recent pond inflows.

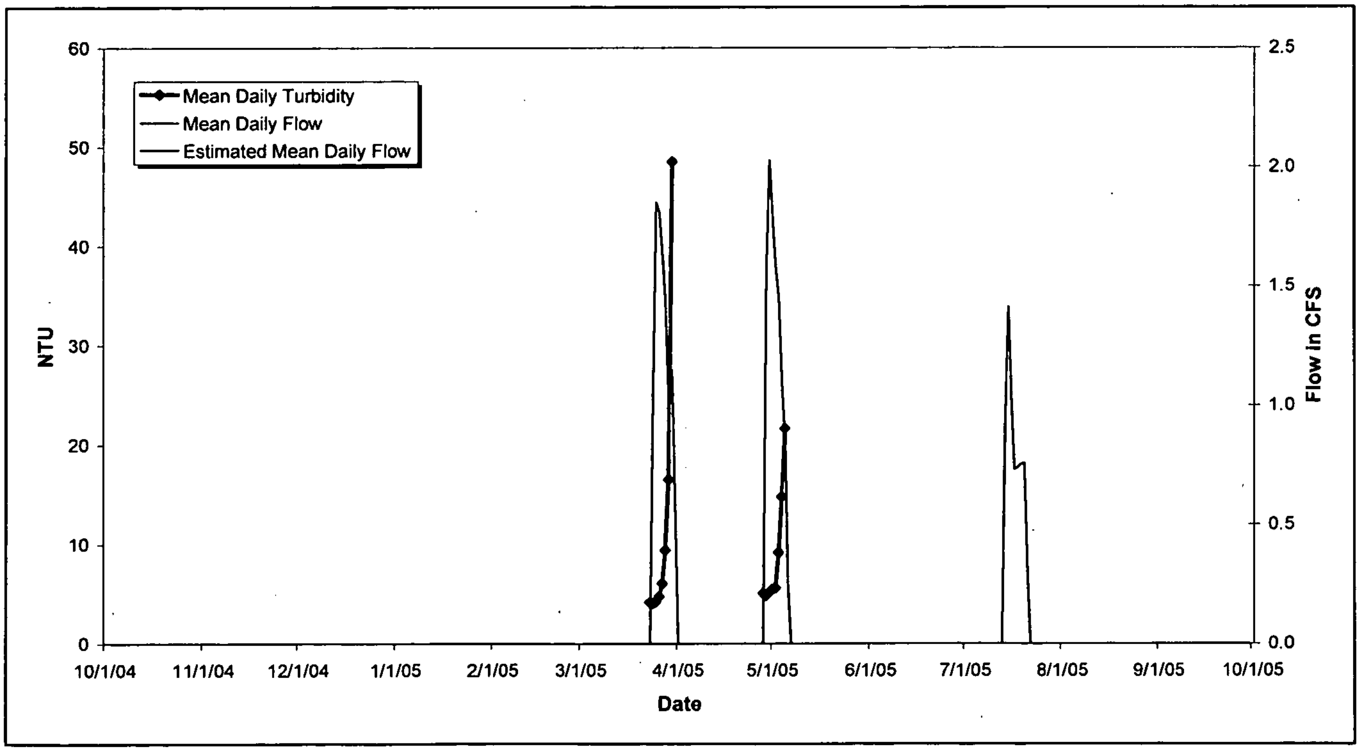


Figure 12-36. Mean Daily Turbidity at GS11: WY05.

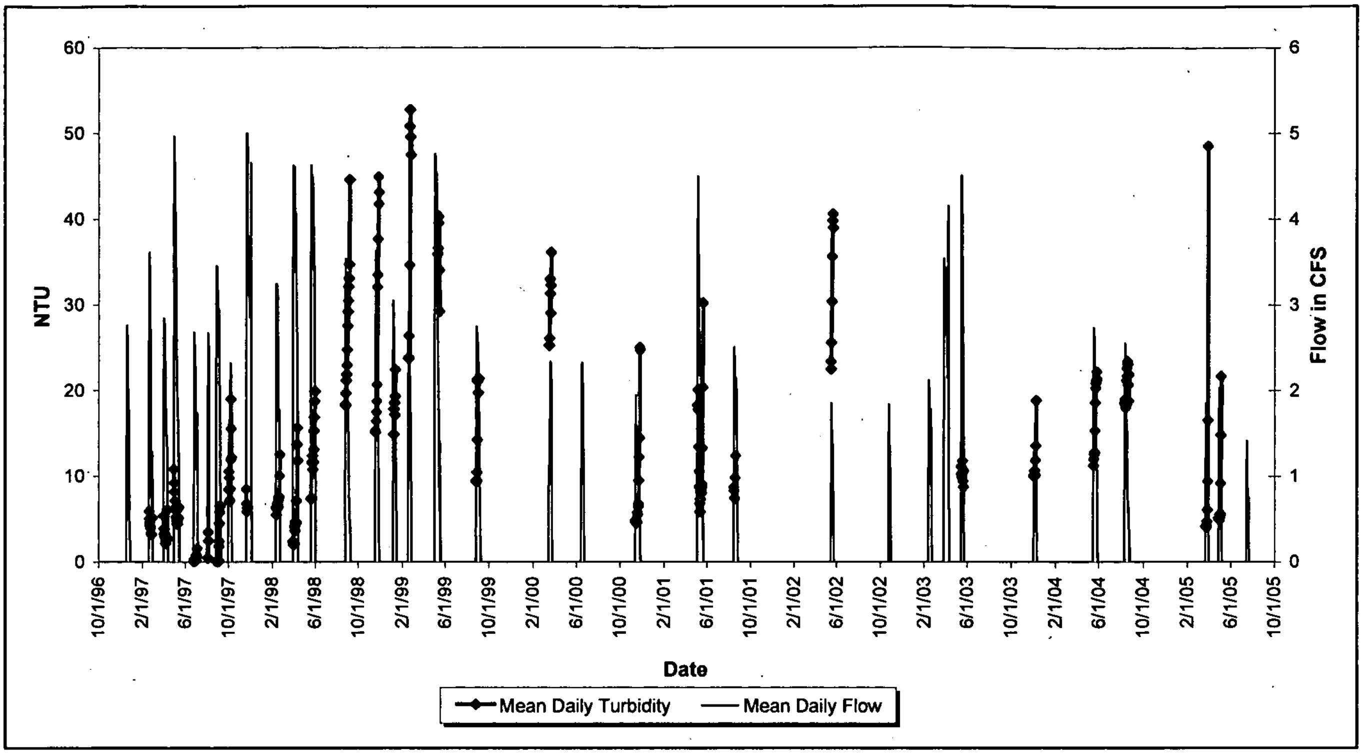


Figure 12-37. Mean Daily Turbidity at GS11: WY97-05.

12.3.5 Location GS31

Monitoring location GS31 is located on Woman Creek at the outlet of Pond C-2. Figure 3-52 shows the drainage area for GS31. The southern portion of the IA contributes flow to GS31.

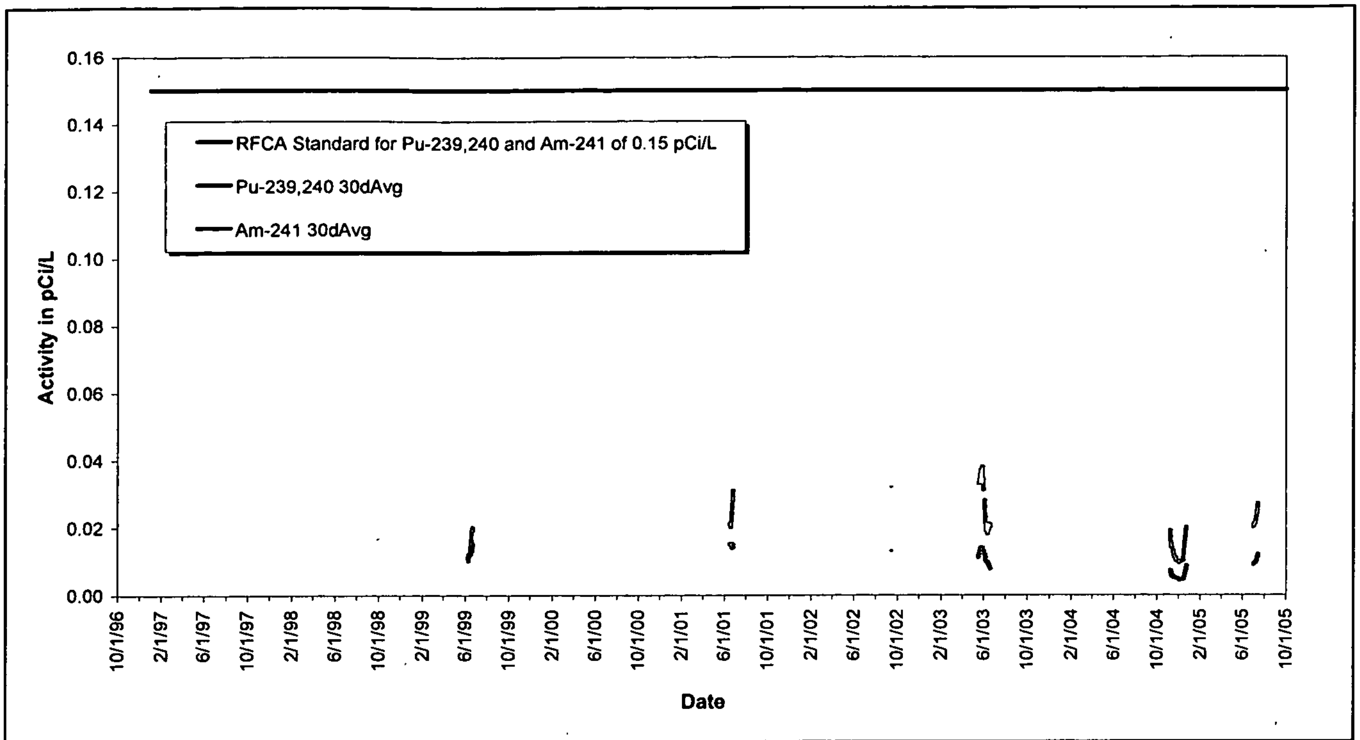
Table 12-13 shows that all of the annual average Pu and Am activities were below the 0.15 pCi/L standard. Additionally, the long-term Pu and Am averages (WY97-05) are below the 0.15 pCi/L standard. The average uranium activities are all well below the 11 pCi/L standard.

Figure 12-38 and Figure 12-39 show no occurrences of reportable 30-day averages.

Figure 12-42 shows the rolling 12-month averages (see Appendix B.1: Data Evaluation Methods). It can be seen that by using this method the variability is 'dampened' by the longer evaluation period, more values are calculated using a calendar window, and no values are reportable at the 0.15 pCi/L standard.

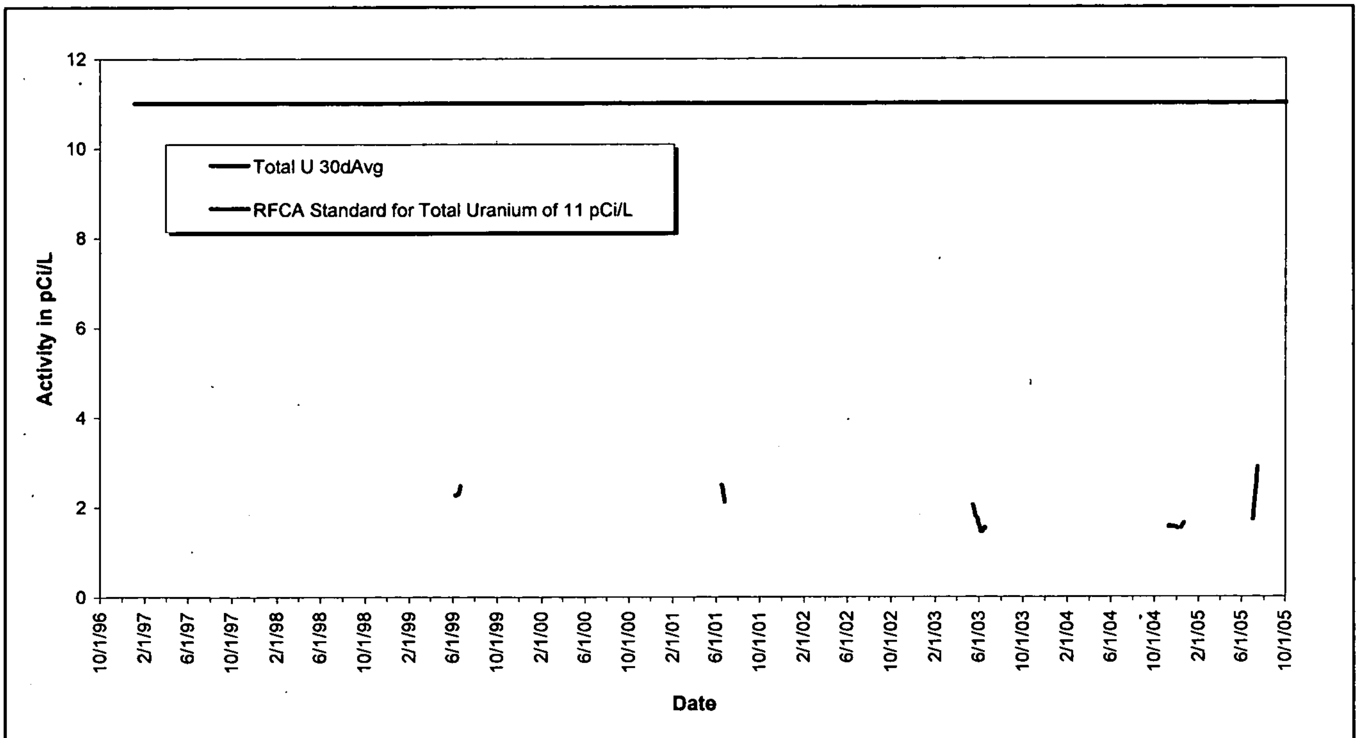
Table 12-13. Annual Volume-Weighted Average Radionuclide Activities at GS31 in WY97-05.

	Volume-Weighted Average Activity (pCi/L)		
Water Year	***Am-241***	***Pu-239,240***	***Total Uranium***
1997	0.005	0.018	2.48
1998	0.015	0.009	2.22
1999	0.010	0.043	2.70
2000	No C-2 Discharge	No C-2 Discharge	No C-2 Discharge
2001	0.013	0.021	1.250
2002	0.015	0.089	2.43
2003	0.006	0.015	1.62
2004	No C-2 Discharge	No C-2 Discharge	No C-2 Discharge
2005	0.009	0.020	2.42
Total (WY97-05)	0.011	0.019	2.13



Note: 30 days of flow were not available for use in calculation until during WY99 (6/6/99), the 4th C-2 discharge after the start of RFCA monitoring.

Figure 12-38. Volume-Weighted 30-Day Average Pu and Am Activities at GS31: WY97–05.



Note: 30 days of flow were not available for use in calculation until during WY99 (6/6/99), the 4th C-2 discharge after the start of RFCA monitoring.

Figure 12-39. Volume-Weighted 30-Day Average Total Uranium Activities at GS31: WY97–05.

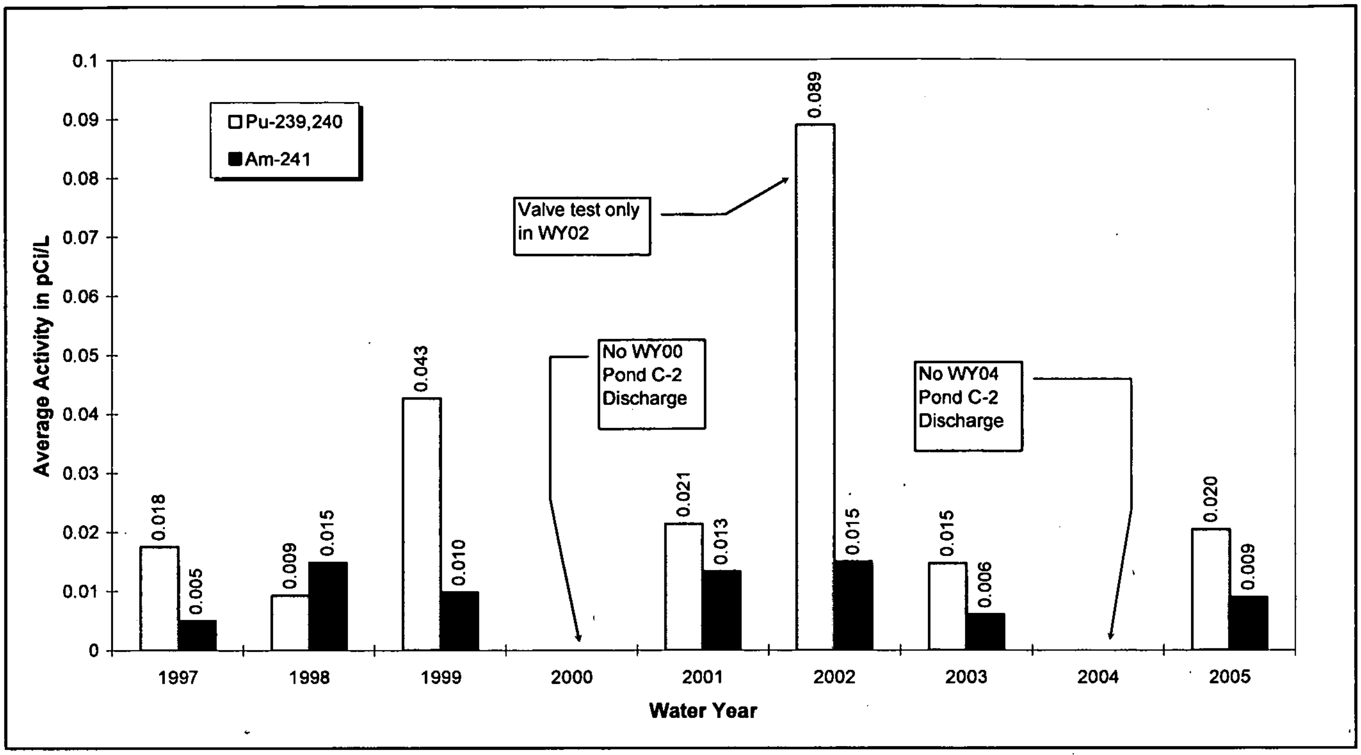


Figure 12-40. Annual Volume-Weighted Average Pu and Am Activities at GS31: WY97–05.

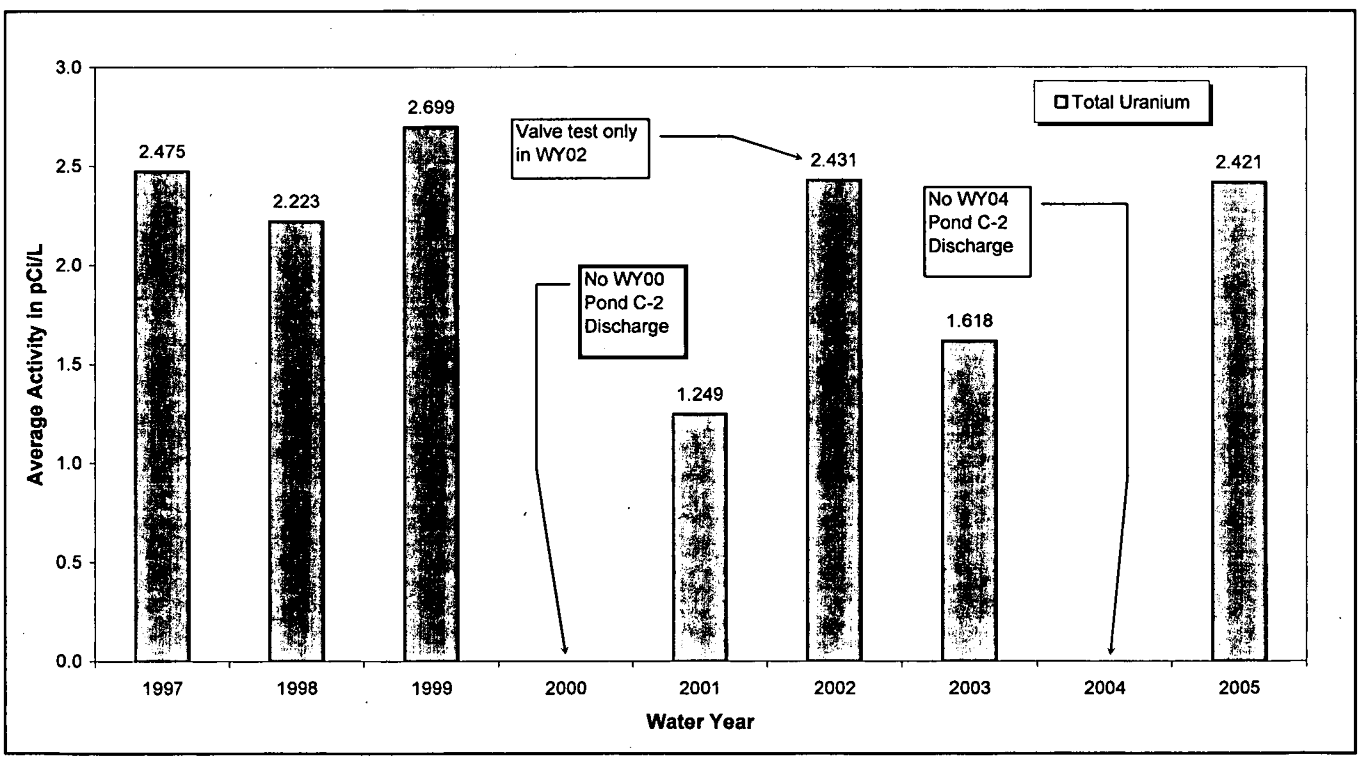
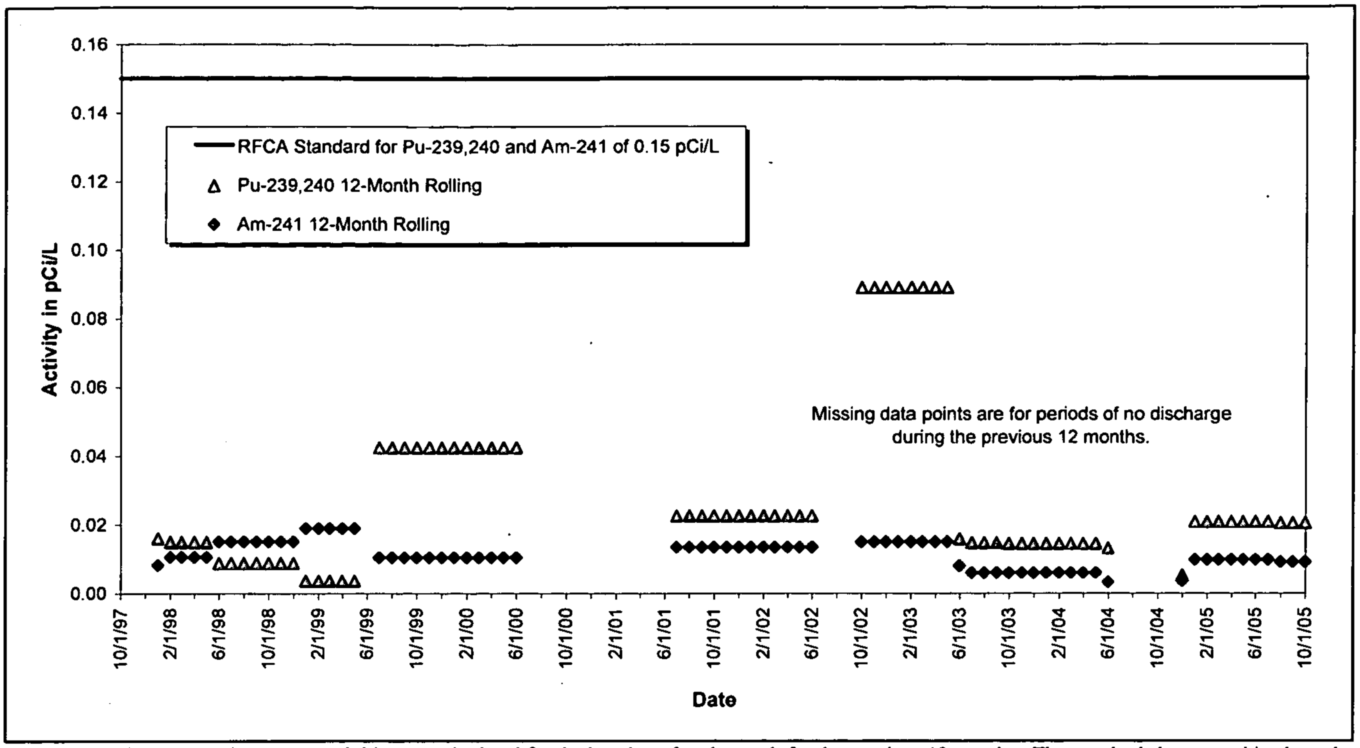
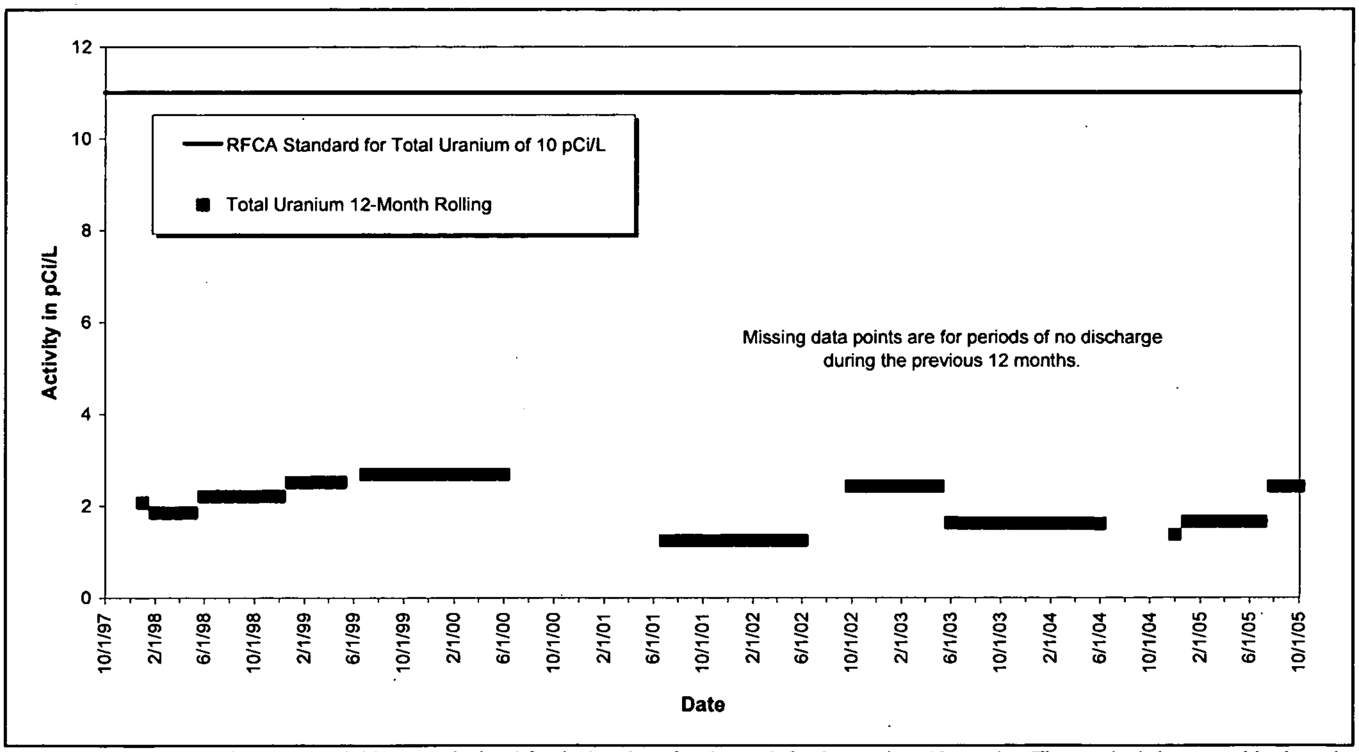


Figure 12-41. Annual Volume-Weighted Average Total Uranium Activities at GS31: WY97–05.



Note: The rolling 12-month average activities are calculated for the last day of each month for the previous 12 months. The standard shown on this plot only applies to 30-day averages. It is shown here for reference only.

Figure 12-42. Rolling 12-Month Average Pu and Am Activities at GS31: WY98–05.



Note: The rolling 12-month average activities are calculated for the last day of each month for the previous 12 months. The standard shown on this plot only applies to 30-day averages. It is shown here for reference only.

Figure 12-43. Rolling 12-Month Average Total Uranium Activities at GS31: WY97–05.

Mean daily water-quality parameter data are plotted in Figure 12-45 through Figure 12-51 along with the mean daily flow rate. Figure 12-44 and Figure 12-45 show the expected annual variation in water temperature.

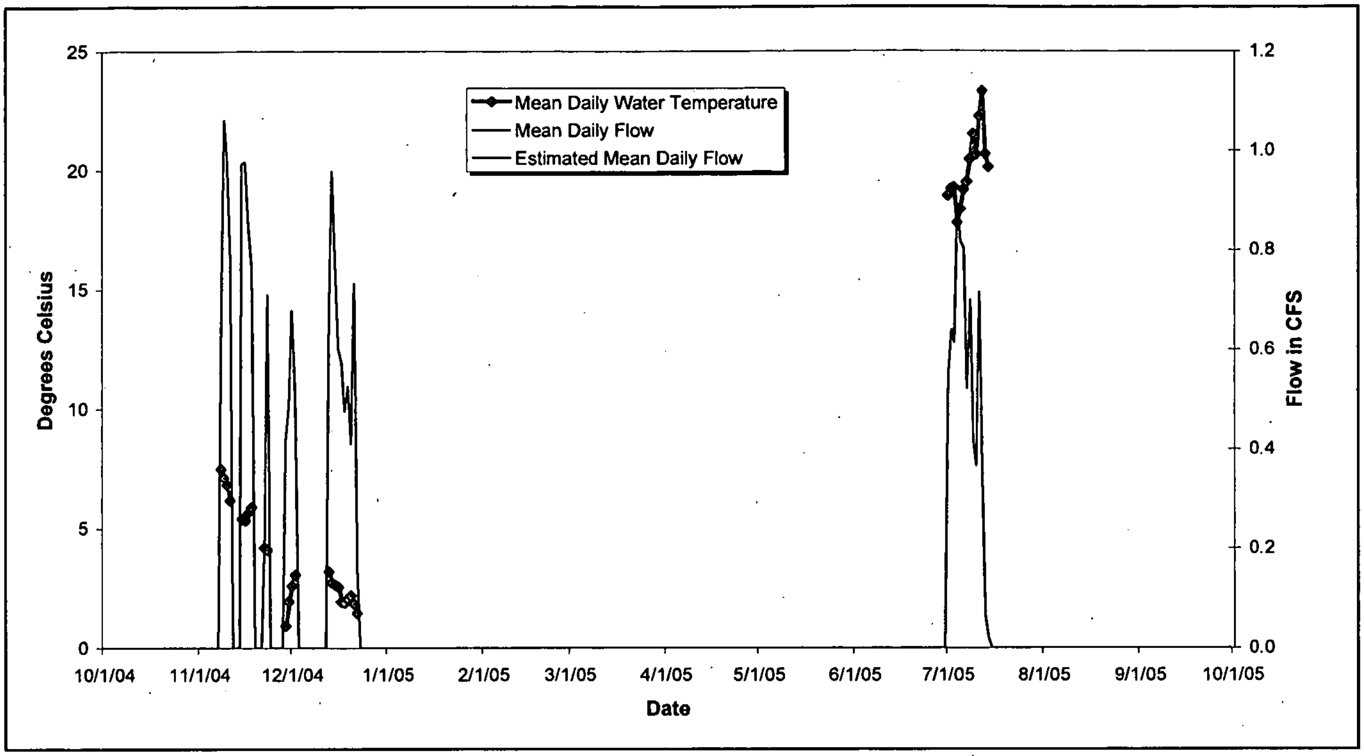


Figure 12-44. Mean Daily Water Temperature at GS31: WY05.

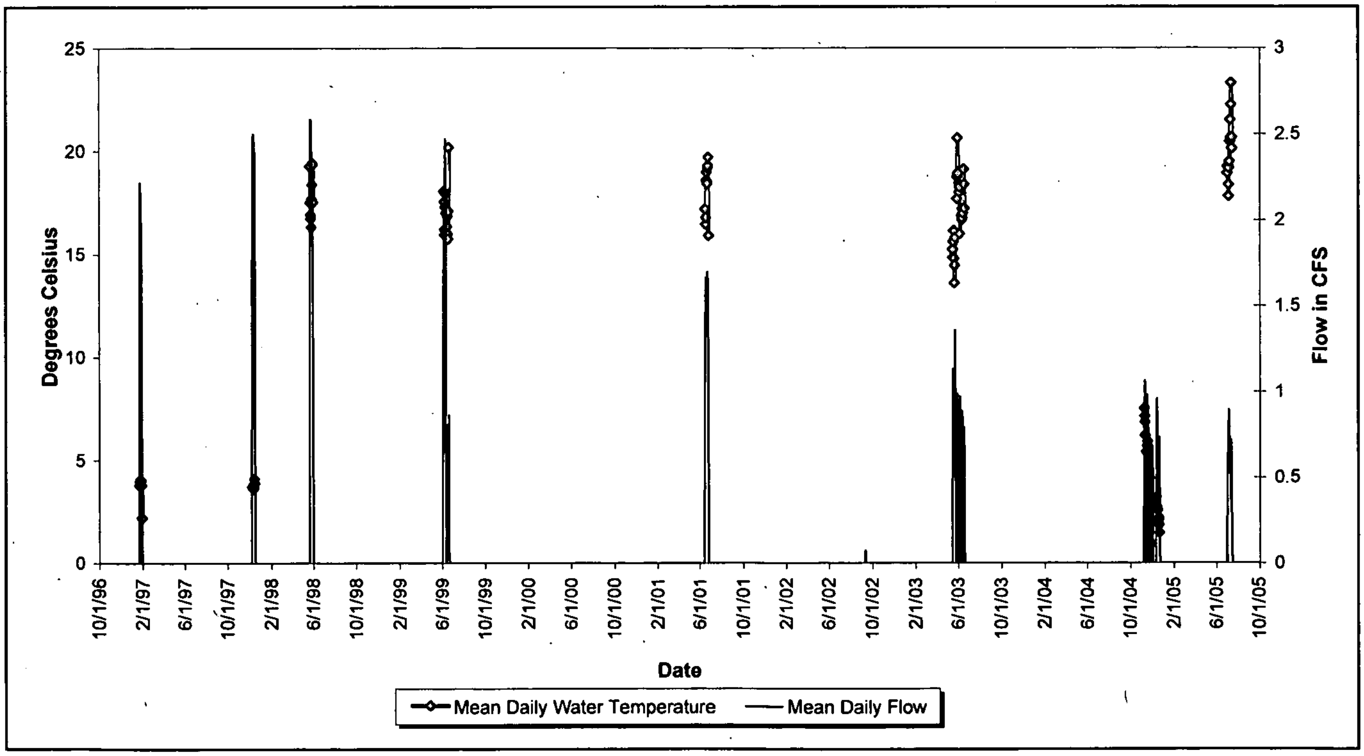


Figure 12-45. Mean Daily Water Temperature at GS31: WY97-05.

Figure 12-47 shows fairly constant conductivities for each Pond C-2 discharge. The higher conductivities are likely caused by runoff that entered C-2 during previous winter months, likely a result of changes in deicing products (magnesium chloride) starting in WY00.

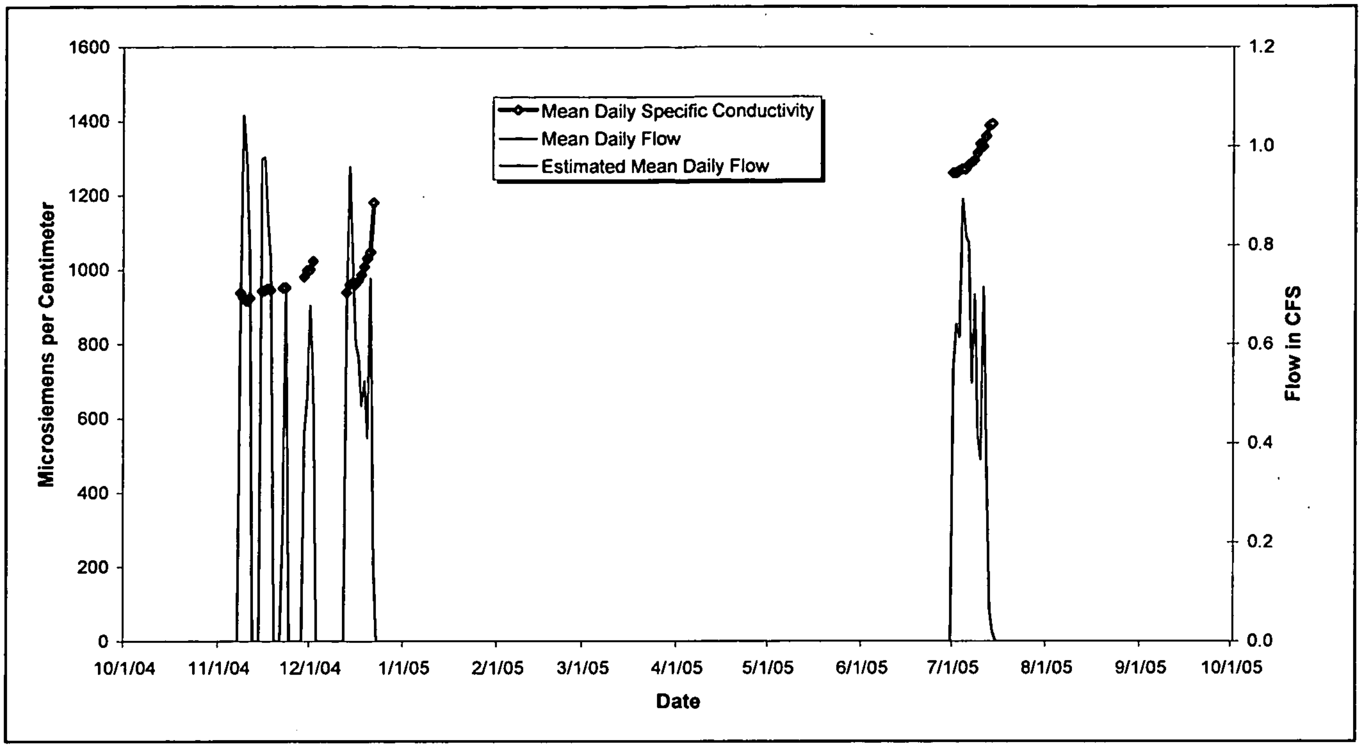


Figure 12-46. Mean Daily Specific Conductivity at GS31: WY05.

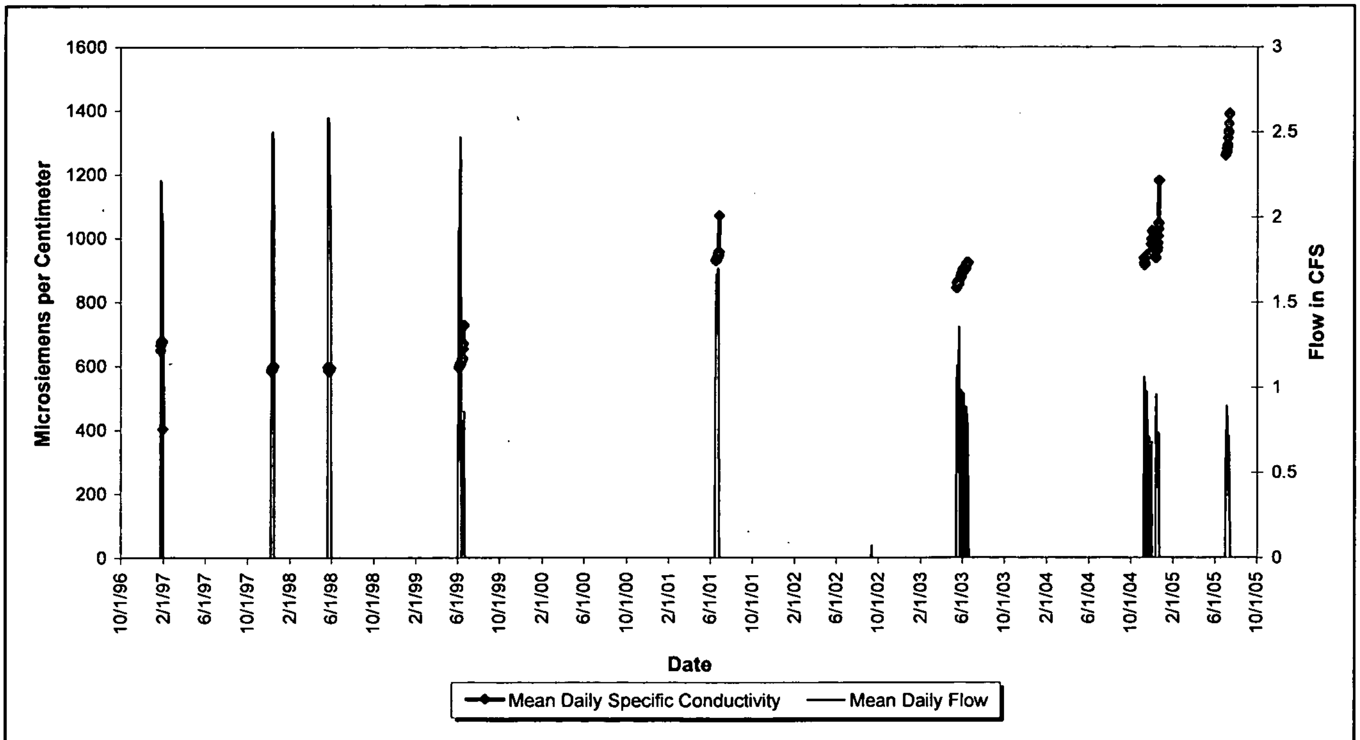


Figure 12-47. Mean Daily Specific Conductivity at GS31: WY97-05.

Figure 12-48 and Figure 12-49 show the mean daily pH varying between 4.9 and 8.3. The low pH in WY05 may have been due to a calibration error.

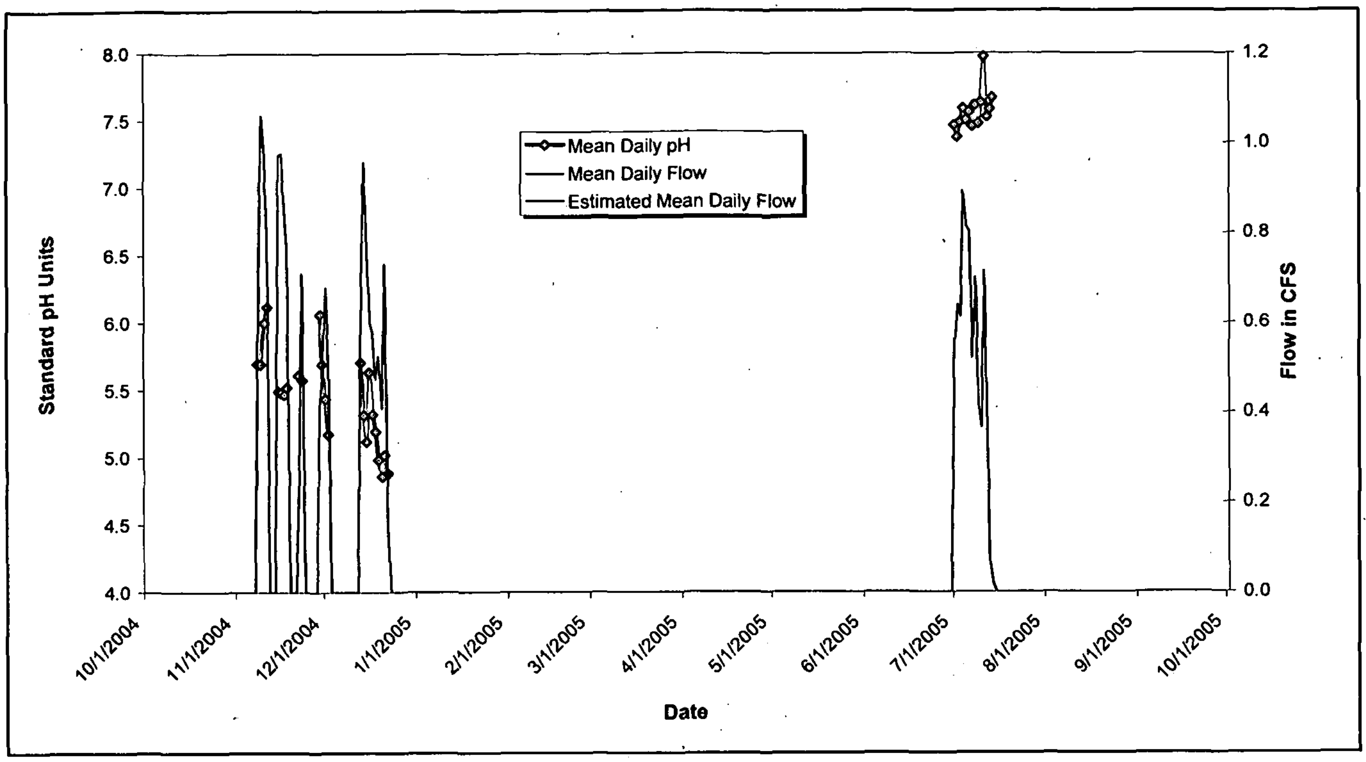


Figure 12-48. Mean Daily pH at GS31: WY05.

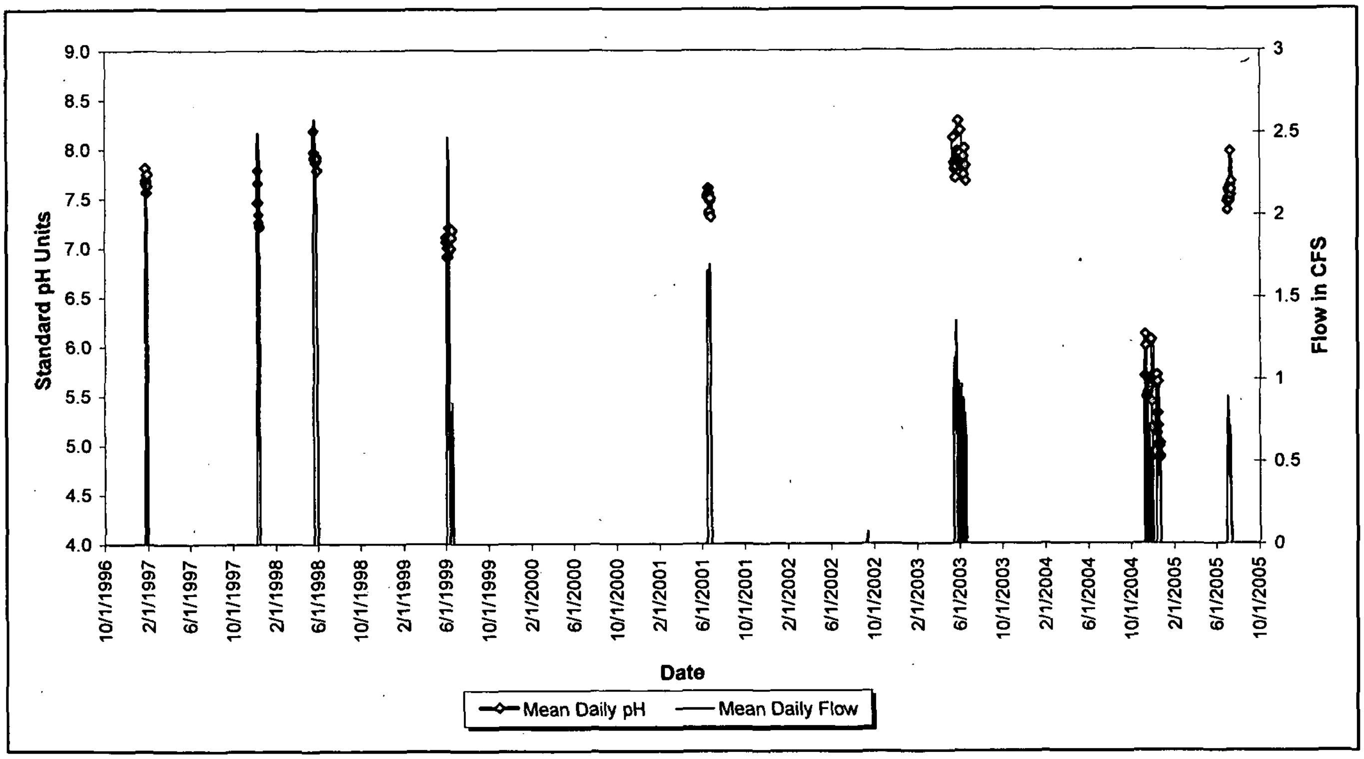


Figure 12-49. Mean Daily pH at GS31: WY97-05.

Finally, Figure 12-50 and Figure 12-51 shows variable turbidity measurements. These variations are likely the result of biological growth in the pond and/or turbidity from recent pond inflows. The higher turbidities at the end of the WY99, WY01, WY03, and WY04 discharges are due to valve tests and pond dewatering.

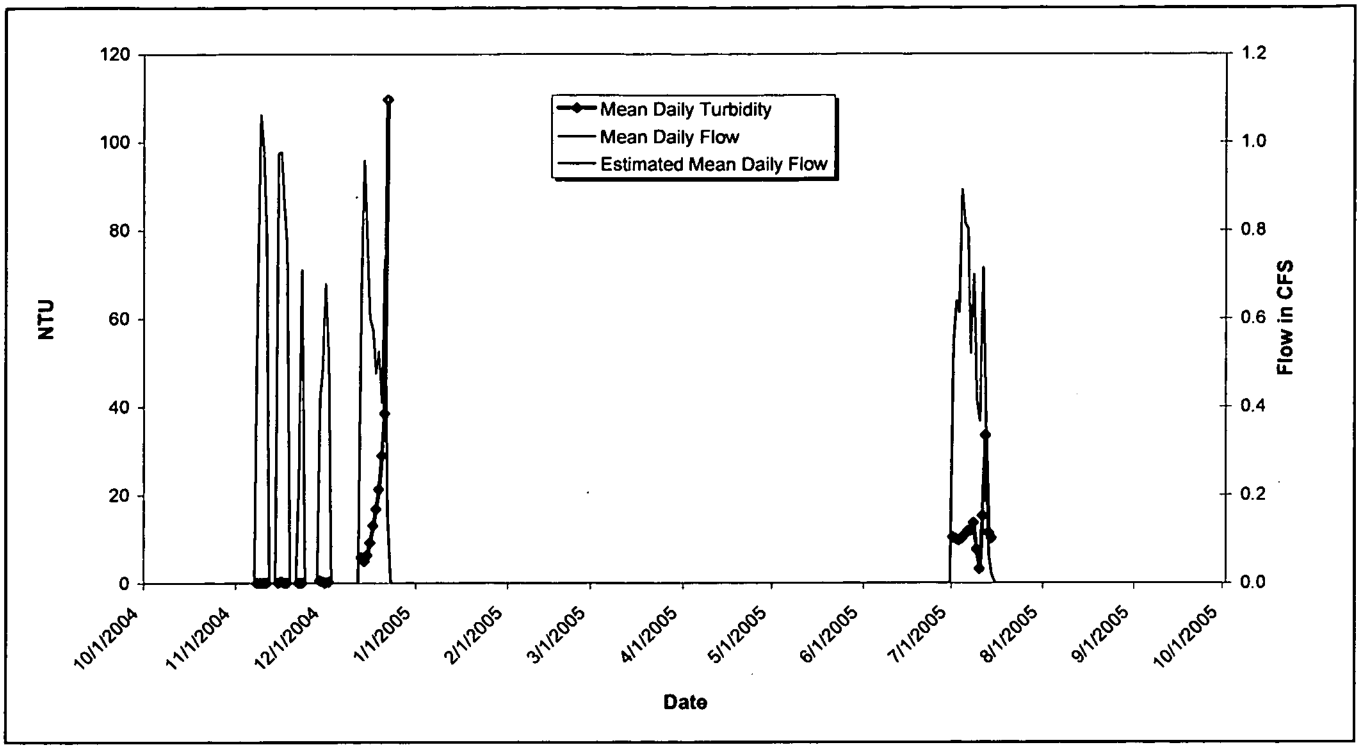


Figure 12-50. Mean Daily Turbidity at GS31: WY05.

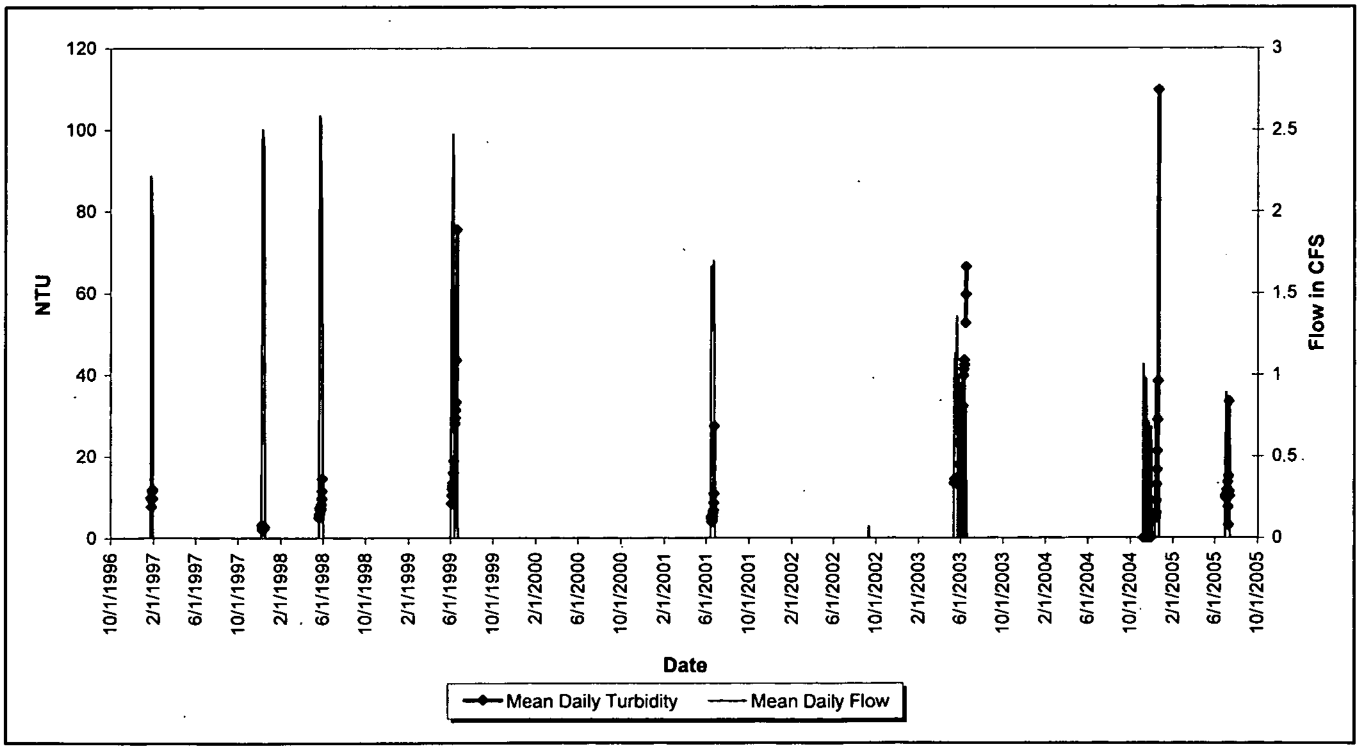


Figure 12-51. Mean Daily Turbidity at GS31: WY97-05.

12.4 STREAM SEGMENT 4 POINT OF COMPLIANCE SUMMARY

12.4.1 Location GS01

- During WY97-05, there were no reportable 30-day average values for Pu, Am, or total uranium at GS01.

12.4.2 Location GS03

- During WY97-05, there were no reportable 30-day average values for Pu, Am, or total uranium at GS03.

12.4.3 Location GS08

- During WY97-05, there were no reportable 30-day average values for Pu, Am, or total uranium at GS08. However, between 9/14/00 and 11/24/00 five values of 0.15 pCi/L Pu were observed. Although not required to perform a source evaluation, the Site did produce a report. The *Source Evaluation Report for RFCA Point of Compliance GS08: Water Years 2000-2001* (RMRS, 2001c) was completed in May 2001.
- Using the rolling 12-month average calculation method, no values are reportable during WY97-05, compared to the 0.15 pCi/L standard.

12.4.4 Location GS11

- During WY97-05, there were no reportable 30-day average values for Pu, Am, or total uranium at GS11.
- Using the rolling 12-month average calculation method, no values are reportable during WY97-05, compared to the 0.15 pCi/L standard.

12.4.5 Location GS31

- During WY97-05, there were no reportable 30-day average values for Pu, Am, or total uranium at GS31.
- Using the rolling 12-month average calculation method, no values are reportable during WY97-05, compared to the 0.15 pCi/L standard.

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13. NON-POC MONITORING AT INDIANA STREET

The State of Colorado has proposed to conduct this non-POC monitoring as a prudent management action, and it is the intent of the RFCA parties that no enforcement action will be taken on the basis of this monitoring. Metals monitoring of flows coming from the IA is done by RFETS at POEs. This monitoring, in combination with D&D project-specific monitoring (Performance Monitoring), should detect significant changes in loadings of metals to surface waters from the IA. In addition to this monitoring, CDPHE will be monitoring metals in North and South Walnut Creek below the Solar Ponds, Mound and East Trenches Plumes to assess loadings from these only other known potential sources of metals above the A-, B-, and C-Series Ponds.

Still, the ponds themselves have likely accumulated sediments containing some metals. As RFETS progresses to closure, the hydrology of the stream and pond system is likely to change, with a gradual reduction in domestic water supply and wastewater effluent. The effect of both reduced flows (domestic water supply leakage and wastewater effluent) and reduced nutrient loading into the B-Series Ponds on stream and pond chemistry is unknown.

Therefore, the monitoring described in this section is done to ensure that metal concentrations leaving RFETS meet stream standards and to provide an assessment of nutrients and physical parameters that might explain any observed changes in metal concentrations over time.

Since the primary focus of this monitoring is to obtain an assessment of chemistry changes within the ponds, only pond releases are monitored. As a practical matter, flows other than pond releases are only significant as a result of direct precipitation runoff, which will be difficult to accurately assess with only grab sampling provided by CDPHE.

13.1 DATA TYPES, FREQUENCY, AND COLLECTION PROTOCOLS

The complete list of parameters and analytes (analytes collected by CDPHE) is given in Table 13-1. Only the continuously-measured water-quality parameters pH and conductivity are collected by the Site.

Table 13-1. Non-POC Monitoring Analytes and Parameters.

Analyte	Number of Samples
Total ammonia	5
Nitrate/Nitrite	5
Total phosphate as P	5
Orthophosphate	5
Ag, Cu, Mn, Ni, Se (dissolved)	5
As, Be, Cd, Cr, Fe, Li (total)	5
Total Hardness, as $CaCO_3$	5
pH	Continuous 15-min intervals
Temperature	Continuous 15-min intervals
Conductivity	Continuous 15-min intervals
Flow	Continuous 15-min intervals

Non-POC monitoring is limited to Stream Segment 4, as represented by samples taken from Walnut Creek at Indiana Street and Woman Creek at Indiana Street (GS03 and GS01 respectively, see Figure 12-1).

13.2 WY05 MONITORING SCOPE

Table 13-2. Non-POC Monitoring Locations.

Location Code	Location	Primary Flow Measurement Device	Telemetry
GS01	Woman Creek and Indiana St.	9" Parshall Flume	Yes
GS03	Walnut Creek and Indiana St.	6" and 36" Parallel Parshall Flumes; 3' HL-Flume installed 2/12/03	Yes

Table 13-3. Non-POC Field Data Collection: Parameters and Frequency.

Location Code	Parameters		
	Discharge	Real-Time pH and Conductivity	Precipitation
GS01	15-min continuous	15-min continuous	5-min continuous
GS03	15-min continuous	15-min continuous	5-min continuous

Notes: Parameters are measured opportunistically when continuous flow is present and freezing conditions will not damage the probes.

13.3 DATA EVALUATION

No specific data evaluations are required of the Site for this monitoring objective.

Plots of mean daily water temperature, specific conductivity, and pH for the Indiana Street POCs (GS01 and GS03) are given below.[66] More detailed data for all parameters are presented in Appendix B.5.2. The methods used for the water-quality parameter evaluations are given in Appendix B.5: Real-Time Water-Quality Parameters.

13.3.1 Location GS01

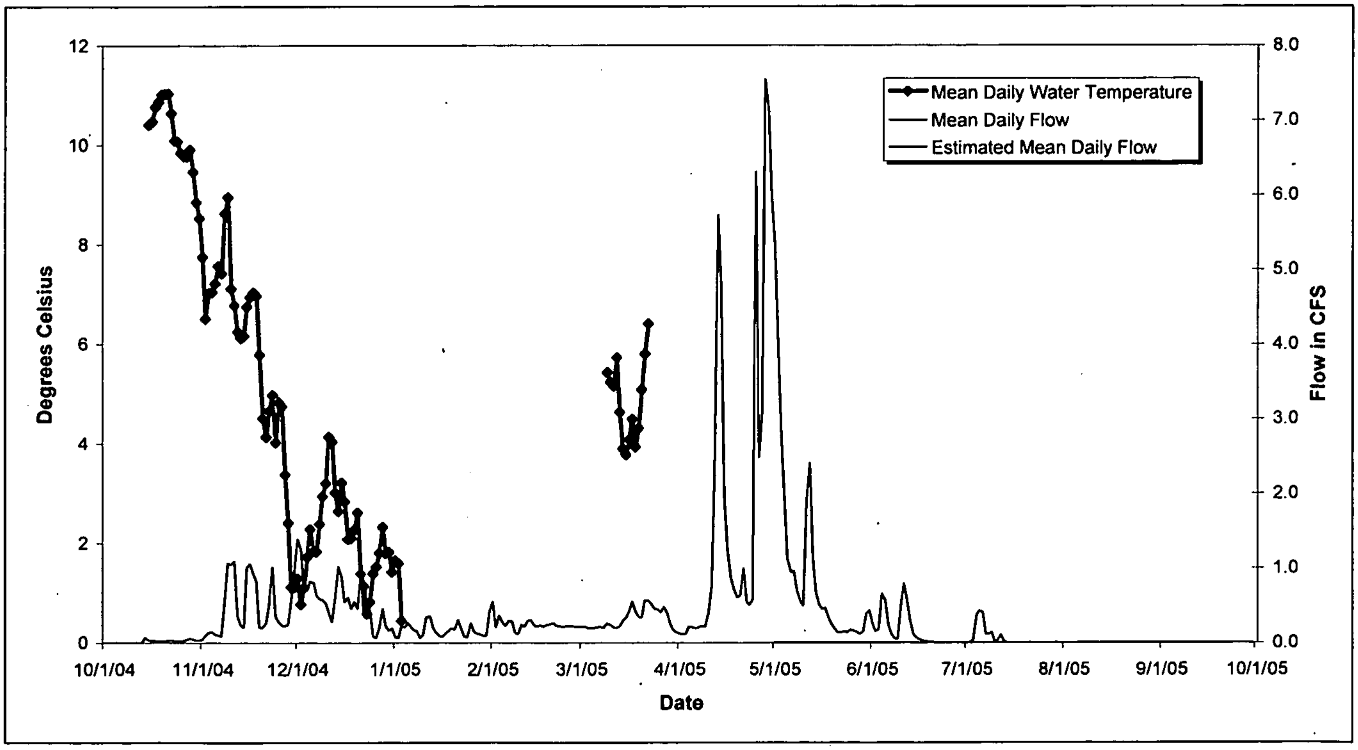

Figure 13-1. Mean Daily Water Temperature at GS01: WY05.

[66] Mean daily water-quality values are given for days of measurable flow. Some data may be missing due to equipment failures and removal for calibration.

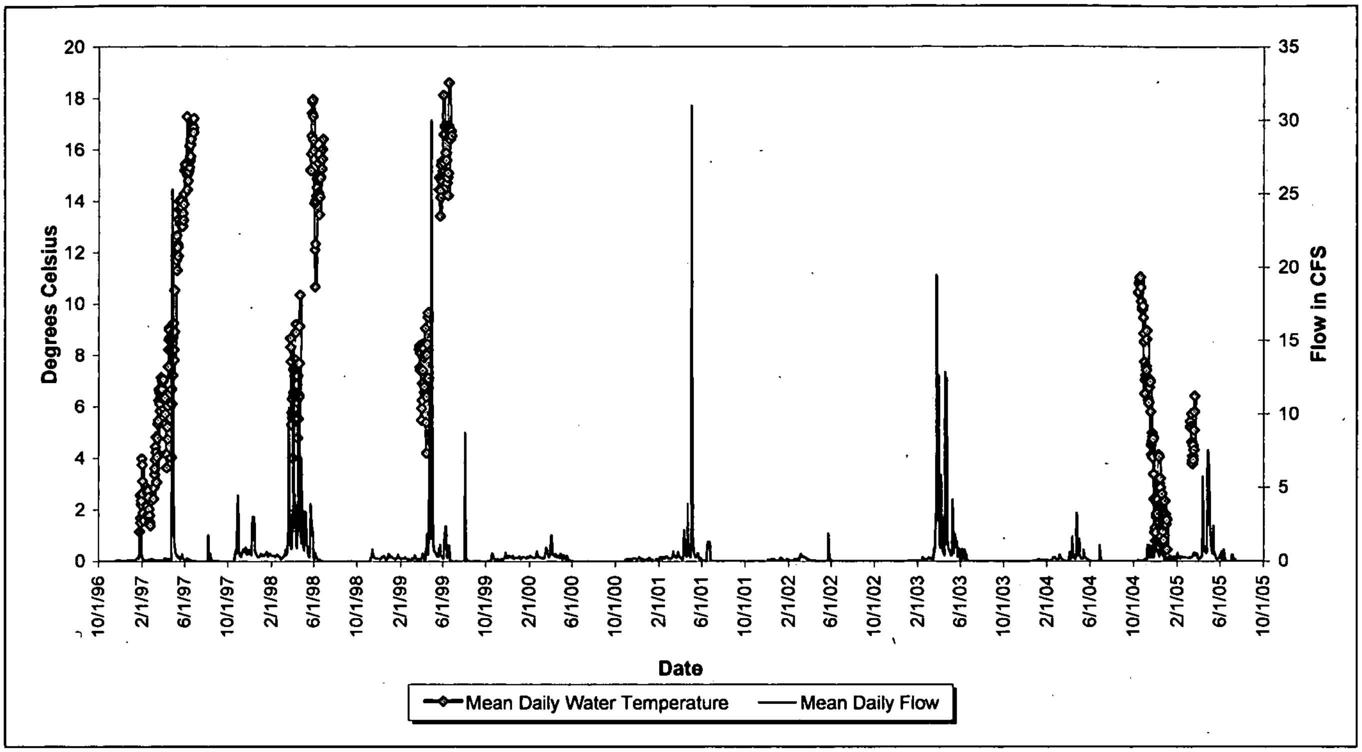

Figure 13-2. Mean Daily Water Temperature at GS01: WY97-05.

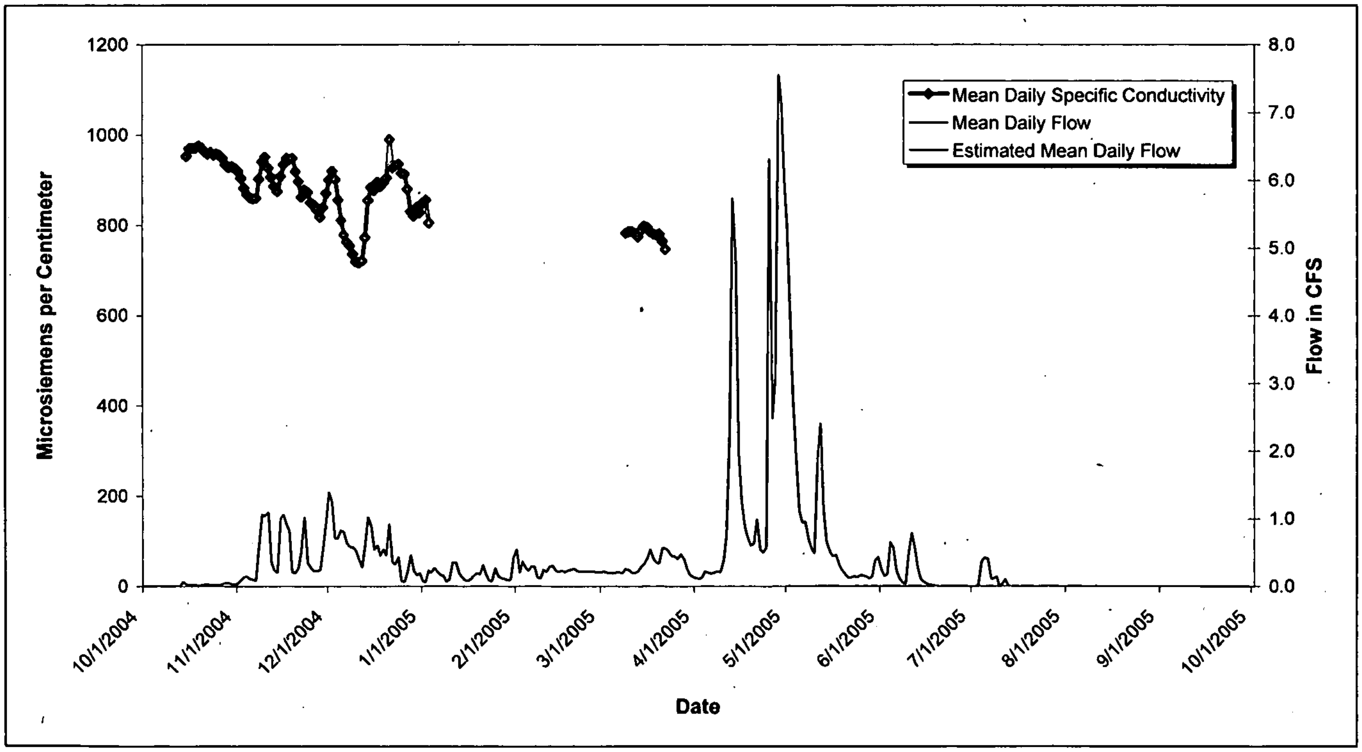

Figure 13-3. Mean Daily Specific Conductivity at GS01: WY05.

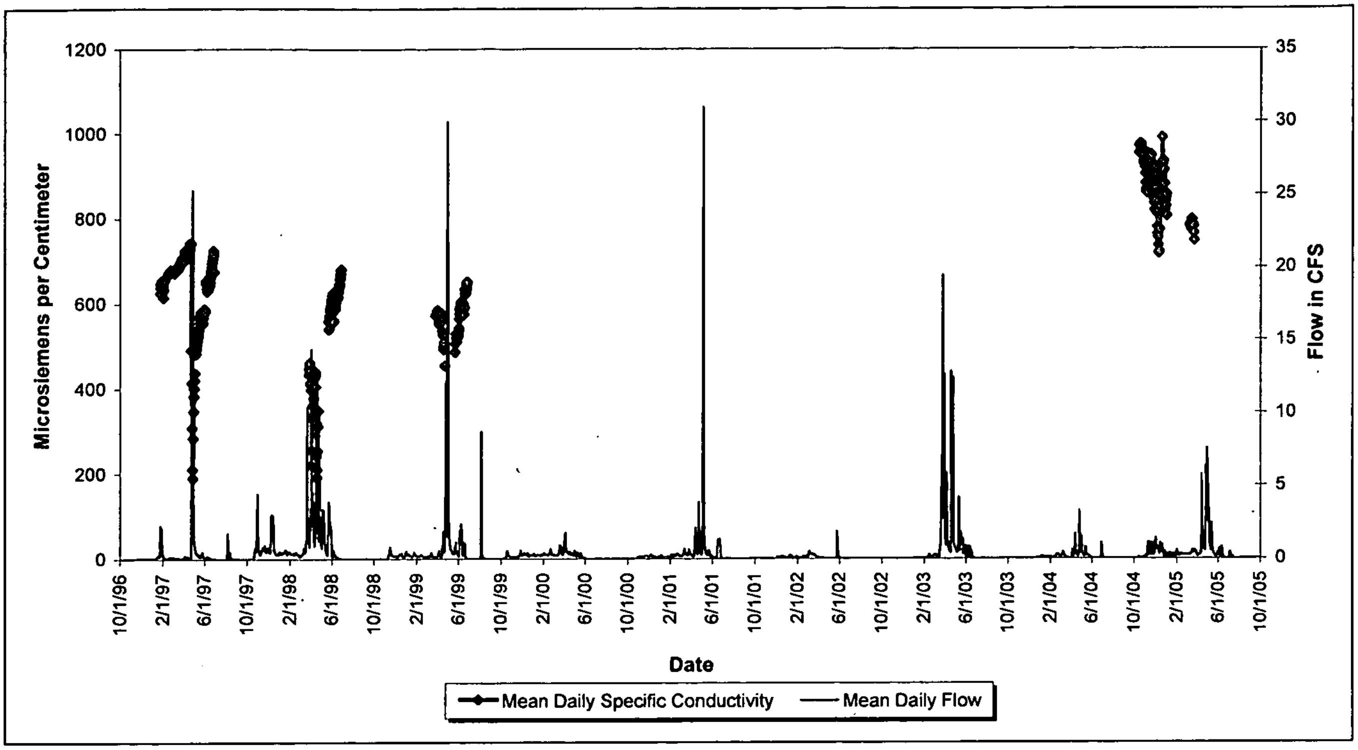

Figure 13-4. Mean Daily Specific Conductivity at GS01: WY97-05.

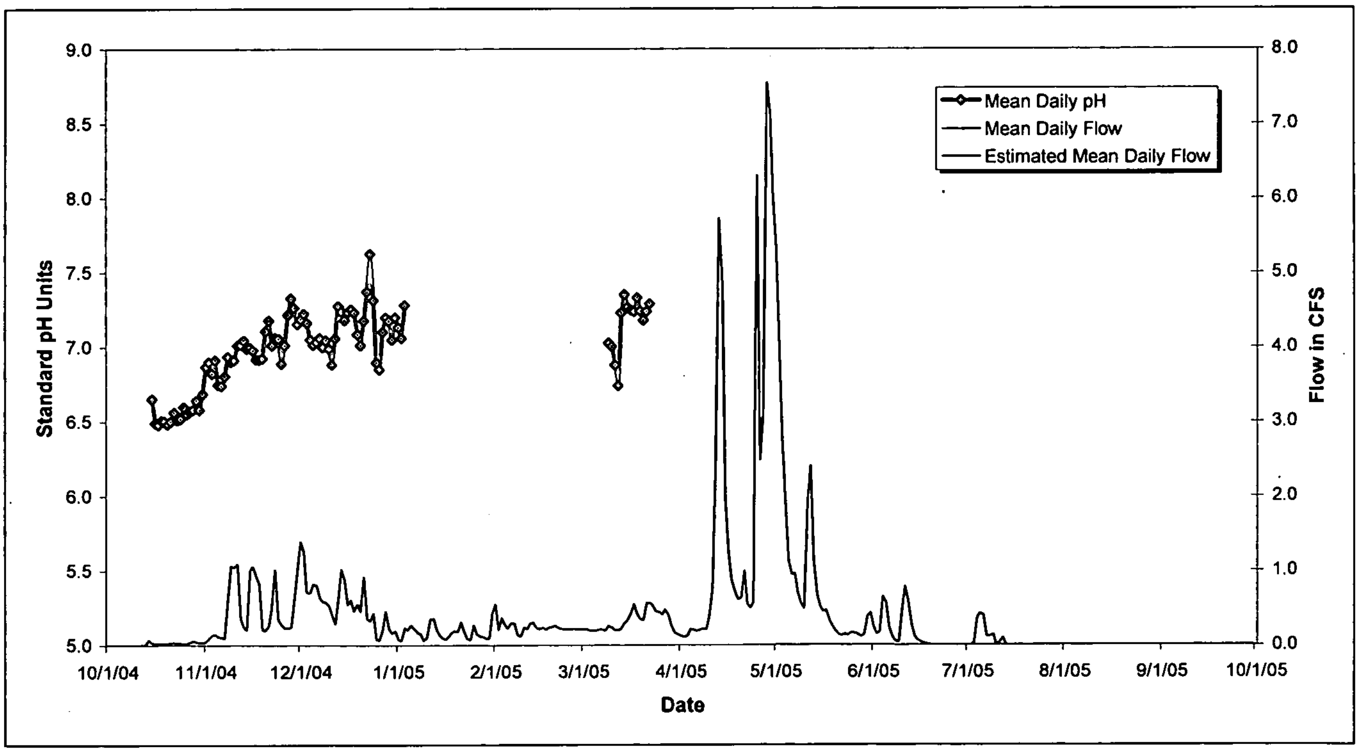

Figure 13-5. Mean Daily pH at GS01: WY05.

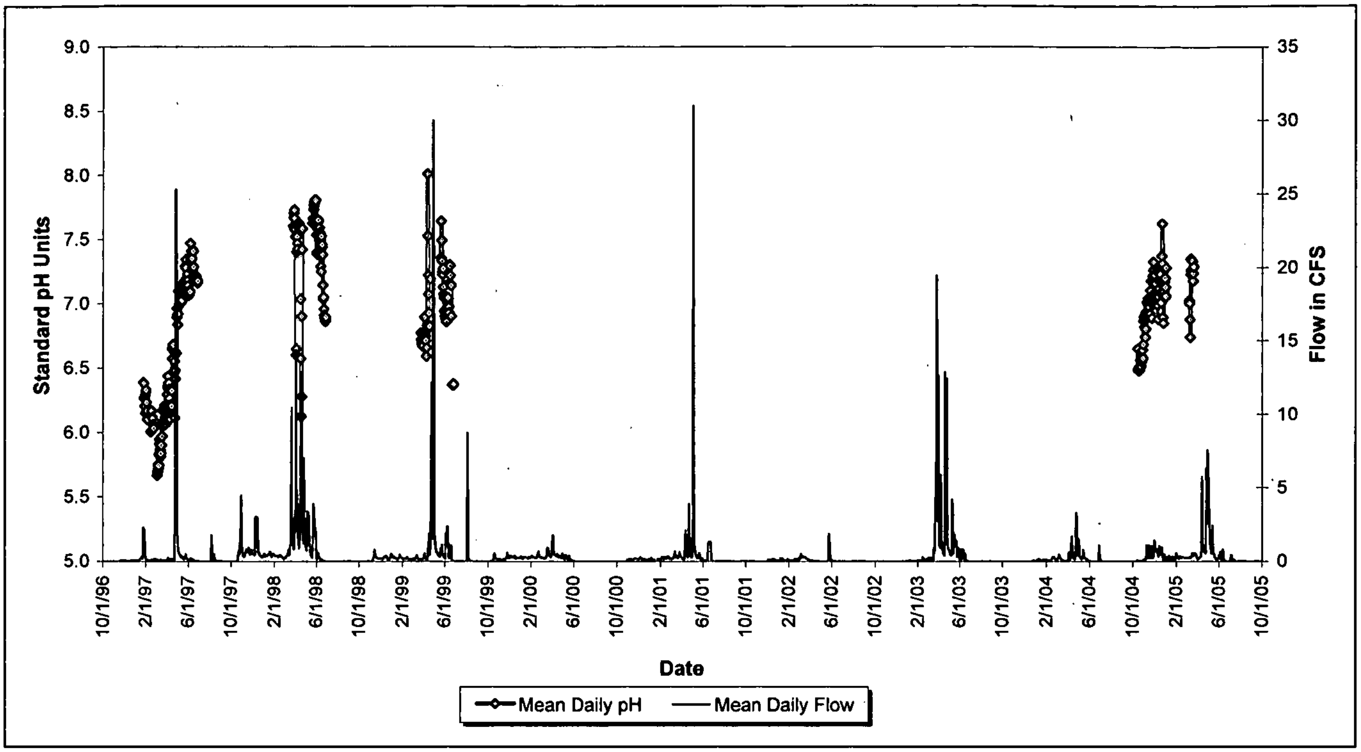

Figure 13-6. Mean Daily pH at GS01: WY97-05.

13.3.2 Location GS03

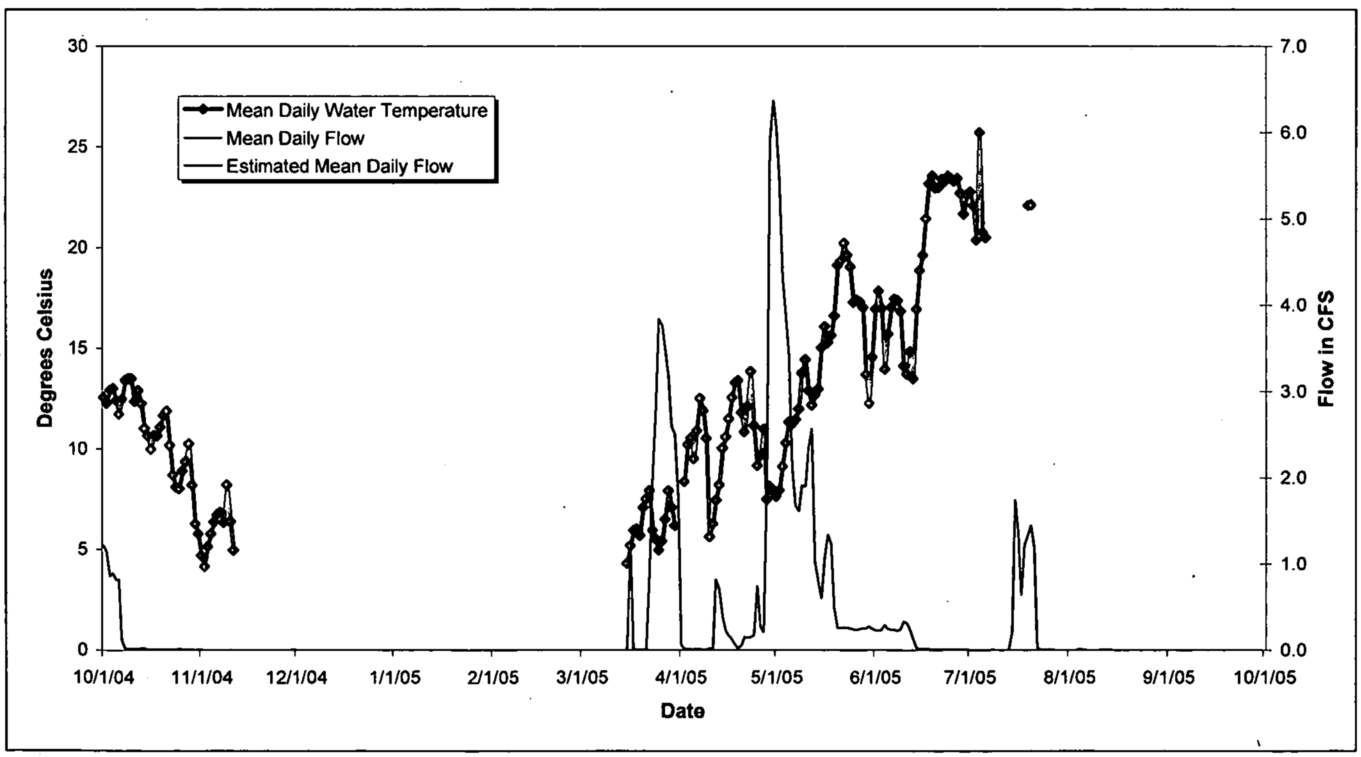

Figure 13-7. Mean Daily Water Temperature at GS03: WY05.

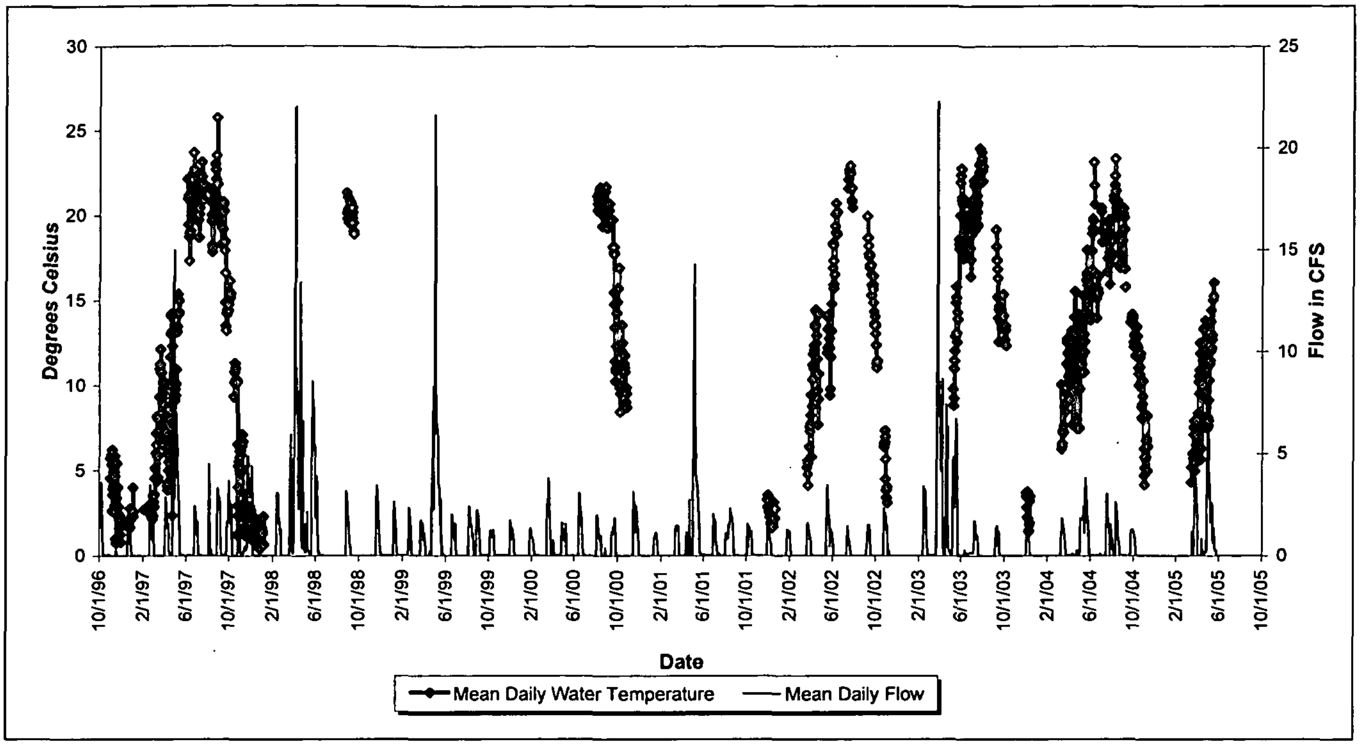

Figure 13-8. Mean Daily Water Temperature at GS03: WY97-05.

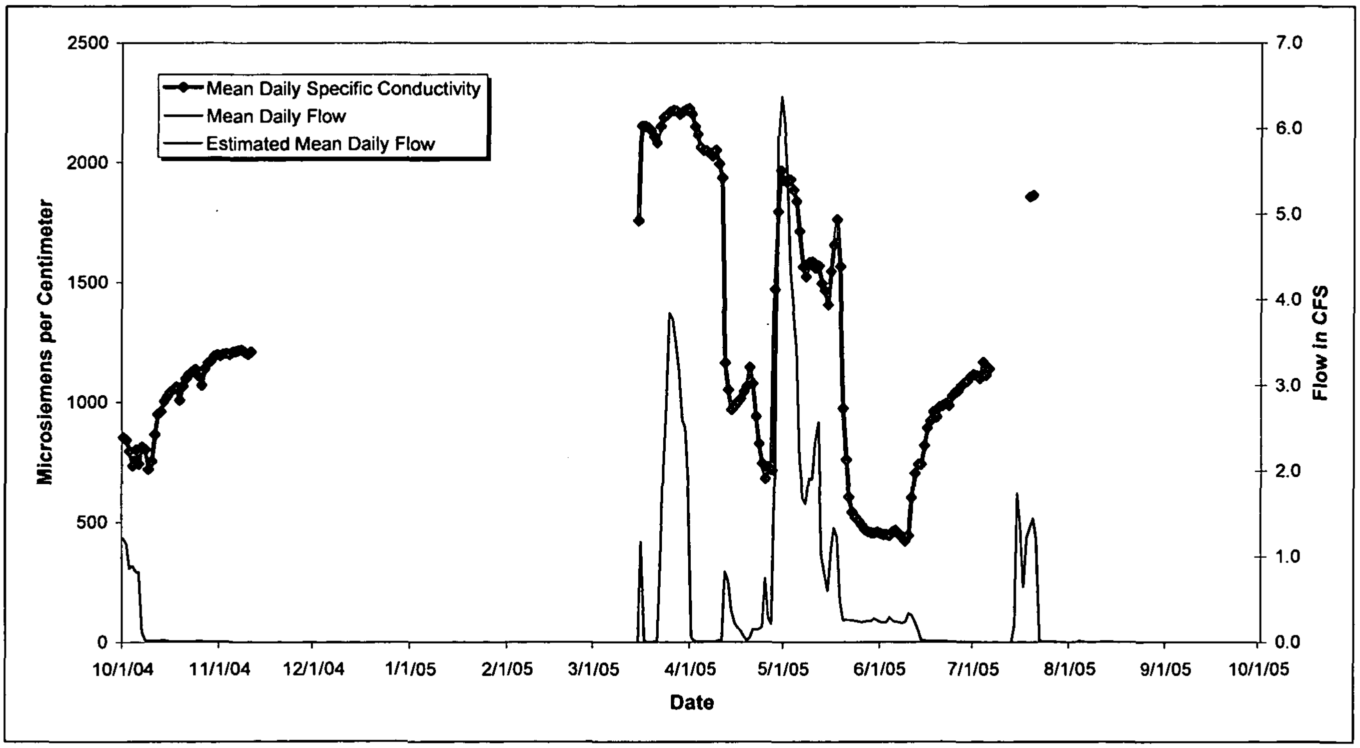

Figure 13-9. Mean Daily Specific Conductivity at GS03: WY05.

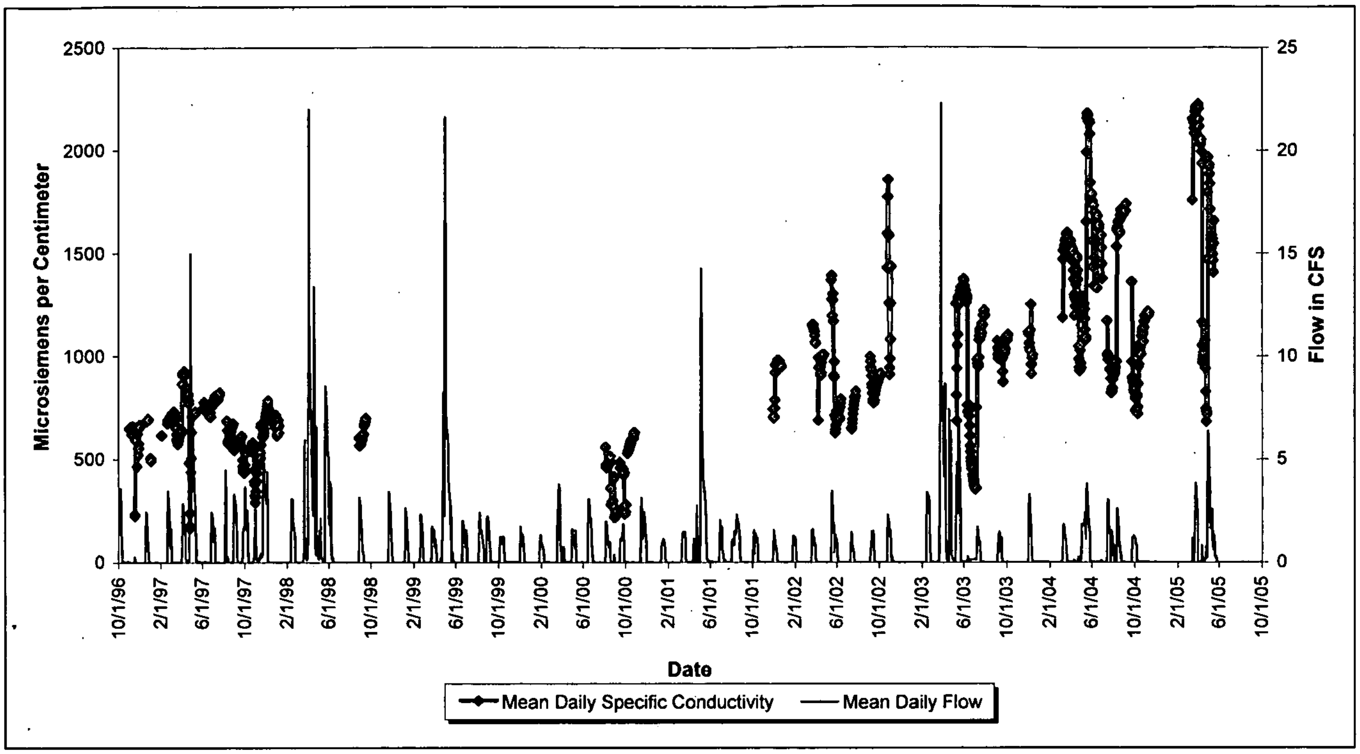

Figure 13-10. Mean Daily Specific Conductivity at GS03: WY97-05.

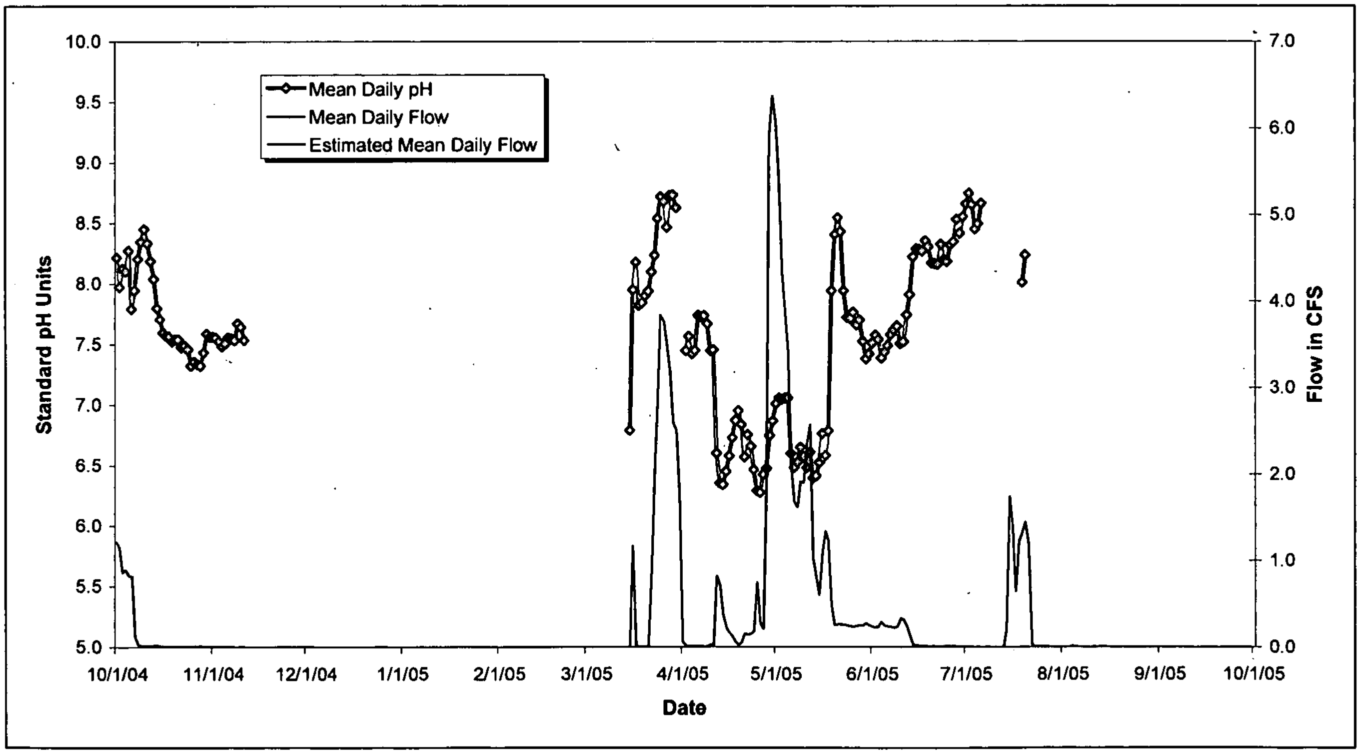

Figure 13-11. Mean Daily pH at GS03: WY05.

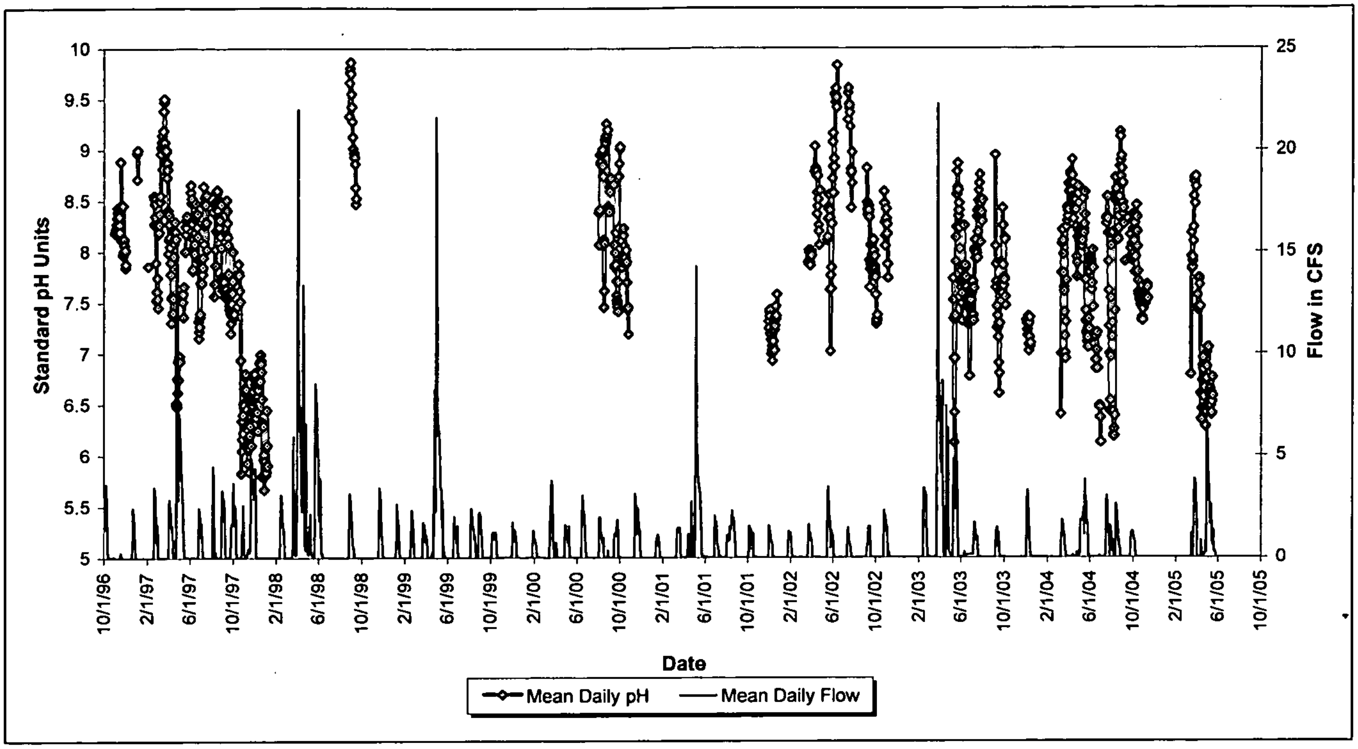

Figure 13-12. Mean Daily pH at GS03: WY97-05.

14. BUFFER ZONE HYDROLOGIC MONITORING

Buffer Zone hydrologic monitoring is performed to characterize interactions between the various environmental media. Possible interactions are presented in Table 14-1, which represents a conceptual model of integrated monitoring at the Site

As indicated in Table 14-1, there are interactions between surface water, air, groundwater, and the flora and fauna of the Site. Concerns have been expressed that changes in flow into and out of the Site could impact habitat and species of concern both onsite and downstream (e.g. the Prebles meadow jumping mouse onsite and whooping cranes in Nebraska). For example, aggregate mining activities west of the Site may alter surface water flowing onto the Site and could impact species of concern on Site and downstream. The DOE, RFPO could be held responsible for these impacts. Also, Site closure activities (e.g. closure of the Building 995 WWTP and modification of the Interceptor Trench System) could significantly alter drainage and flow patterns. In fact, water is one of the key abiotic components structuring some of the significant habitats. Should the availability or quality of water be affected by upgradient off-Site activities or upgradient on-Site activities, significant habitats could be adversely affected.

Table 14-1. Interactions Between Media, Significance at RFETS, and Monitoring to Evaluate Interactions.

Interactions Between Media	Significance at RFETS	Monitoring to Evaluate Interactions
Surface Water to Ecology	Potentially significant; surface-water flow and contamination could impact local ecology. However, the local ecology has remained healthy during a variety of climatic and flow conditions.	Data from existing Site-wide surface-water monitoring may be used to assess potential ecological impacts. The ecological monitoring program is also designed to detect ecological changes and assess general ecological health. In addition, project-specific evaluations are conducted to assess potential impacts.
Surface Water to Groundwater	Not significant; groundwater recharge from surface water is not significant.	No monitoring is necessary to characterize or assess groundwater impacts.
Surface Water to Air	Not significant; surface-water quality will not significantly impact air quality (i.e. cause exceedances of air quality standards).	Any significant impacts on air or water quality will be detected by existing DOE, CDPHE, and project-specific monitoring.
Surface Water to Soil	Potentially significant; water in drainages and ponds will not significantly increase contaminant concentrations in soil; however, runoff could spread contaminants on surface soils and increase sediment concentrations.	Soil monitoring is conducted to determine the impacts of surface-water runoff and the extent of required soil removal before, during, and after individual remediation projects. Results of the AME will be used to determine whether existing soil monitoring needs to be modified or expanded.
Groundwater to Surface Water	Significant; most of the Site groundwater flows into Site surface-water drainages.	Existing surface-water monitoring will detect any impacts from groundwater. Data from Site-wide groundwater monitoring (Site-wide and project-specific) are also used to assess and predict potential surface-water impacts.

Interactions Between Media	Significance at RFETS	Monitoring to Evaluate Interactions
Air to Surface Water	Potentially significant; point source and fugitive emission sources could degrade surface-water quality.	Surface-water monitoring (Site-wide and project-specific) will detect increases in contaminant concentrations. Also, any significant impacts on air quality will be detected by existing DOE, CDPHE, and project-specific air monitoring.
Soil to Surface Water	Significant; contaminants in soils are transported to surface water via runoff and surface-water quality is degraded.	Site-wide and project-specific surface-water monitoring will detect increases in contaminant concentrations. Soil monitoring is also conducted to determine the impacts of runoff and the extent of required soil removal before, during, and after individual remediation projects. Results of the AME will be used to determine whether existing soil monitoring needs to be modified or expanded.

In consideration of these potential impacts, watershed-level information is collected regarding water availability in the BZ. Current flow monitoring in the BZ, in addition to that performed under RFCA, is shown in Table 14-2. The flow data are collected at 15-minute intervals, downloaded, and compiled monthly (presented in Section 3). However, DQOs for this monitoring have not yet been developed, and data evaluation to assess ecological impacts is not included in this report

14.1 DATA TYPES, FREQUENCY, AND COLLECTION PROTOCOLS

BZ hydrologic monitoring will be performed only as represented by GS01, GS02, GS03, GS04, GS05, GS06, GS16, SW118, and SW134 (see Figure 14-1).

Sampling at selected BZ stations is performed by collecting storm-event, rising-limb, flow-paced composites. The recommended monitoring design detailed in the IMP was to take samples for WY05 as specified in Table 14-4.

14.2 WY05 MONITORING SCOPE

Table 14-2. BZ Hydrologic Monitoring Locations.

Location Code	Location	Primary Flow Measurement Device	Telemetry
GS01	Woman Creek and Indiana St.	9" Parshall Flume	Yes
GS02	Mower Ditch and Indiana St.	9" Parshall Flume	No
GS03	Walnut Creek and Indiana St.	6" and 36" Parallel Parshall Flumes; 3' HL-Flume installed 2/12/03	Yes
GS04	Rock Creek at Route 128	9" Parshall Flume	Yes
GS05	North Woman Creek at West Site Boundary	9" Parshall Flume	Yes
GS06	South Woman Creek at West Site Boundary	6" Parshall Flume	Yes
GS16	Antelope Springs	6" Parshall Flume	No
SW118	N. Walnut Creek west of Portal 3	169.5° V-Notch Weir	Yes
SW134	Gravel Pits on Rock Creek Near West Site Boundary	6" Parshall Flume	Yes

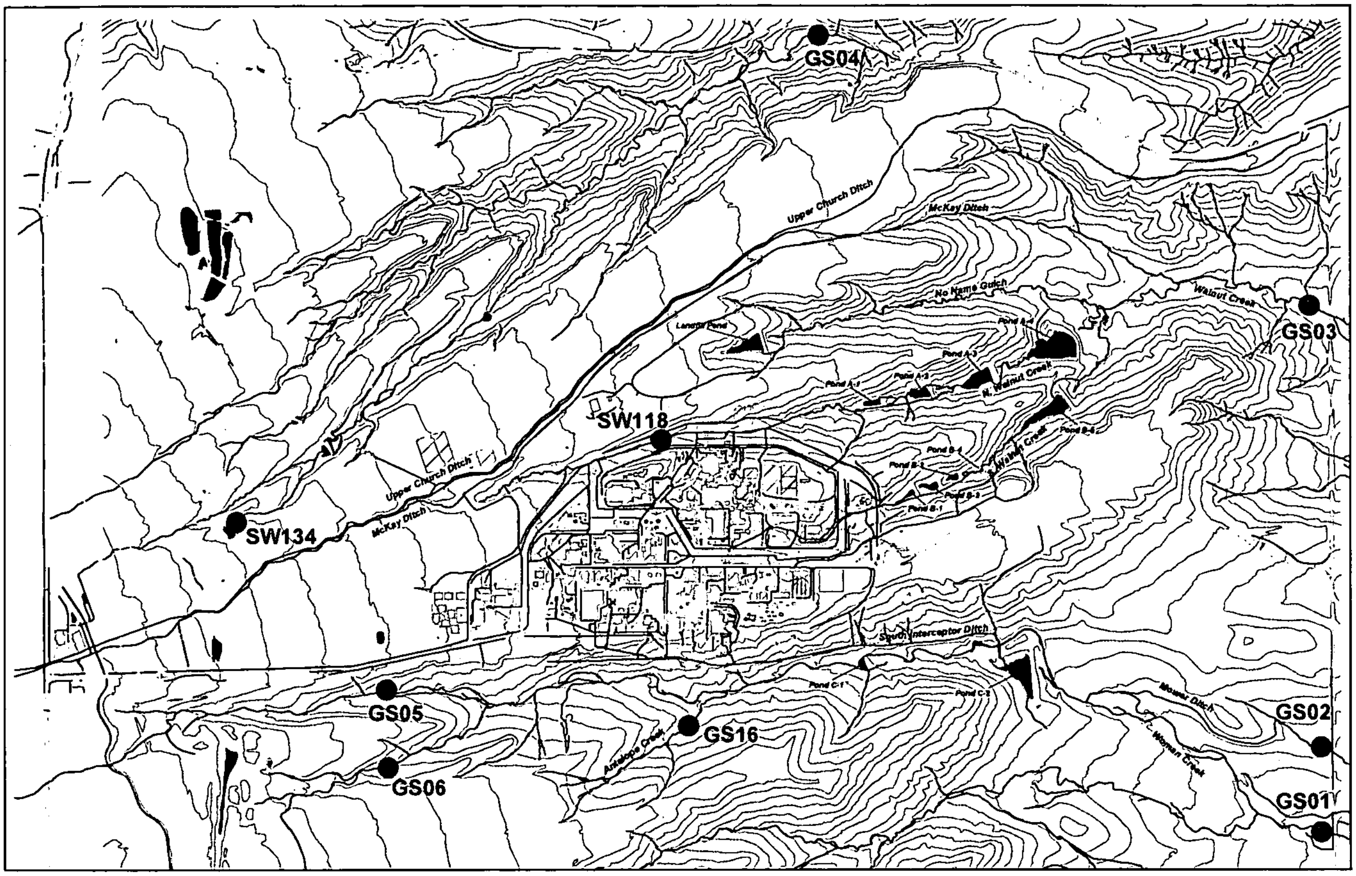

Figure 14-1. WY05 Buffer Zone Hydrologic Monitoring Locations.

Table 14-3. BZ Hydrologic Field Data Collection: Parameters and Frequency.

Location Code	Parameter	
	Discharge	Precipitation
GS01	15-min continuous	15-min continuous
GS02	15-min continuous	NA
GS03	15-min continuous	15-min continuous
GS04	15-min continuous	15-min continuous
GS05	15-min continuous	15-min continuous
GS06	15-min continuous	NA
GS16	15-min continuous	15-min continuous
SW118	15-min continuous	15-min continuous
SW134	15-min continuous	NA

All locations collect 5- and 15-minute flow data.

Table 14-4. BZ Hydrologic Sample Collection Protocols.

Location Code	Frequency	Type[a]
GS01	Quarterly	Storm-event, flow-paced composites
GS02	NA	NA
GS03	Quarterly	Storm-event, flow-paced composites
GS04	Quarterly	Storm-event, flow-paced composites
GS05	NA	NA
GS06	NA	NA
GS16	NA	NA
SW118	NA	NA
SW134	NA	NA

Notes: [a] Sample types are defined in Appendix B.

Table 14-5. BZ Hydrologic Analytical Targets (Analyses per Year).

Location Code	Total Metals: WY05 Actual (Target)
GS01	4 (4)
GS03	2 (4)
GS04	3 (4)

14.3 DATA EVALUATION

Although no routine data evaluations are required, the following preliminary decision rules have been proposed by the IMP:

IF The seasonal average or yearly average water availability or quality entering Rock Creek, Walnut Creek, or Woman Creek drainages diminishes below baseline due to off-Site activities,

THEN The Site will notify Jefferson County and the U.S. Fish and Wildlife Service (USFWS) to determine what actions, if any, should be taken to restore availability and/or quality to historical levels.

IF Activities occurring within Site boundaries result in a depletion of the seasonal or yearly average natural flow greater than the historic baseline, or at rates that are determined to have a negative impact on downstream habitats or individual species,

THEN The Site will determine what management actions should be taken to ameliorate this problem.

IF Significant changes to alluvial groundwater availability in a wetlands habitat are determined,

THEN Notify parties of potential impacts to the wetlands habitat and continue groundwater and ecological monitoring.

IF A proposed action could adversely affect a listed species or its critical habitat,

THEN The Site will consult with the USFWS.

Secondary Data Uses Could Include:

- Determining the impact of mining on Rock Creek water quality and availability;
- Interpreting potential causes of declines in any of the valued habitats on Site;
- Supporting water management planning;
- Evaluating cumulative impacts of all actions (on- and off-Site);
- Validating any predicted impacts of the selected alternative to downstream resources; and
- Supporting the Site's biological assessment and USFWS's biological opinion.

Flow summaries for the BZ locations are given in Section 3: Hydrologic Data. More detailed hydrologic data are given in Appendix A.1: Hydrologic Data.

The following sections present the Buffer Zone Hydrologic data on a location-specific basis for the entire period of BZ Hydro monitoring. Each section includes a table of summary statistics for the location-specific analytes of interest and box plots.

The following evaluations include all results that were not rejected through the verification and validation process. Data are generally presented to decimal places as reported by the laboratories. Accuracy should not be inferred; minimum detectable concentrations/activities and analytical error are often greater than the precision presented. When a sample has a corresponding field duplicate, the value used in calculations is the arithmetic average of the 'real' and the 'duplicate' values. When a sample has multiple 'real' analyses (Site requested 'reruns'), the value used in calculations is the arithmetic average of the multiple 'real' analyses.

For the summary tables, when metals and TSS results are reported by the laboratory as 'undetect', one-half of the detection limit is used for calculation purposes.

Box plots were calculated using S-Plus® statistical evaluation software. For these plots, when metals and TSS results are reported by the laboratory as 'undetect', one-half of the detection limit is used for calculation purposes. A key describing the components of the box plots is given in Appendix B.1: Data Evaluation Methods.

No discussion of the BZ Hydrologic data is provided below. The tables and box plots are intended to summarize the collected data.

14.3.1 Location GS01

Monitoring location GS01 is located on Woman Creek at Indiana Street. Figure 3-10 shows the drainage area for GS01. Table 14-6 presents the analyte-specific summary statistics for BZ samples collected at GS01. Figure 14-2 through Figure 14-7 show the analyte-specific box plots for BZ samples collected at GS01. The southern portion of the IA and Pond C-2 contribute flow to GS01.

Table 14-6. BZ Summary Statistics for Analytical Results from GS01 in WY97-05.

Analyte	Samples [N]	Undetect	Median	85th Percentile	Maximum
TSS [mg/L]	22	45%	2.50	8.55	85.0
CHLORIDE [mg/L]	23	0%	48.0	108	130
FLUORIDE [mg/L]	23	0%	0.44	0.53	0.69
SULFATE [mg/L]	23	0%	37.0	52.4	100
TOTAL ALKALINITY [mg/L]	22	0%	160	180	230
TDS [mg/L]	14	0%	330	408	510
ALUMINUM [µg/L]	28	0%	71.2	254	5010
ANTIMONY [µg/L]	28	71%	0.34	1.00	11.2
ARSENIC [µg/L]	28	75%	0.44	1.49	2.65
BARIUM [µg/L]	28	0%	94.6	112	158
BERYLLIUM [µg/L]	28	64%	0.04	0.23	0.75
CADMIUM [µg/L]	28	89%	0.05	0.09	2.50
CALCIUM [µg/L]	28	0%	53500	66060	80600
CHROMIUM [µg/L]	28	36%	0.42	1.59	4.60
COBALT [µg/L]	28	86%	0.11	0.45	2.65
COPPER [µg/L]	28	14%	1.45	2.50	7.20
IRON [µg/L]	28	4%	82.1	214	3570
LEAD [µg/L]	28	68%	0.36	1.50	3.10
LITHIUM [µg/L]	26	0%	12.2	14.7	38.5
MAGNESIUM [µg/L]	28	0%	14400	18190	23300
MANGANESE [µg/L]	28	4%	3.95	12.3	56.4
MERCURY [µg/L]	27	100%	0.05	0.05	0.10
MOLYBDENUM [µg/L]	26	15%	0.88	1.20	6.45
NICKEL [µg/L]	28	14%	1.00	1.69	6.60
POTASSIUM [µg/L]	28	0%	2090	3377	7700
SELENIUM [µg/L]	28	54%	1.25	2.25	6.30
SILVER [µg/L]	27	93%	0.10	0.20	1.35
SODIUM [µg/L]	28	0%	38100	49780	64400
STRONTIUM [µg/L]	26	0%	373	476	565
THALLIUM [µg/L]	28	93%	0.46	1.00	7.80
TIN [µg/L]	26	96%	0.45	0.78	7.60
VANADIUM [µg/L]	28	11%	0.63	2.10	10.6
ZINC [µg/L]	28	4%	7.70	15.6	26.7

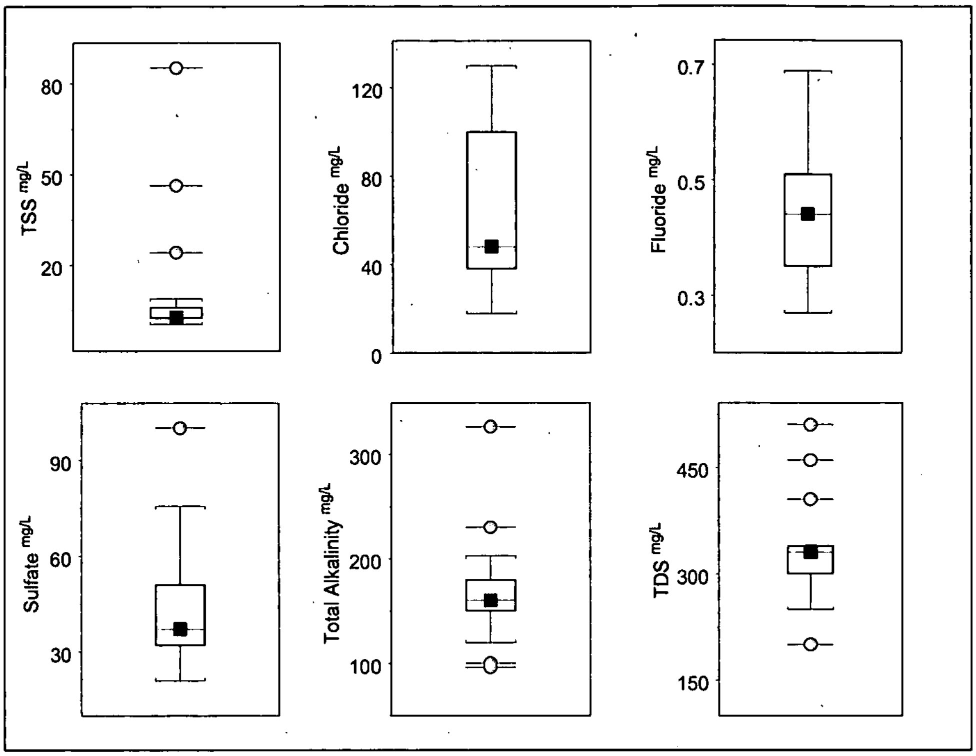

Figure 14-2. Water-Quality Parameter Box Plots for Location GS01.

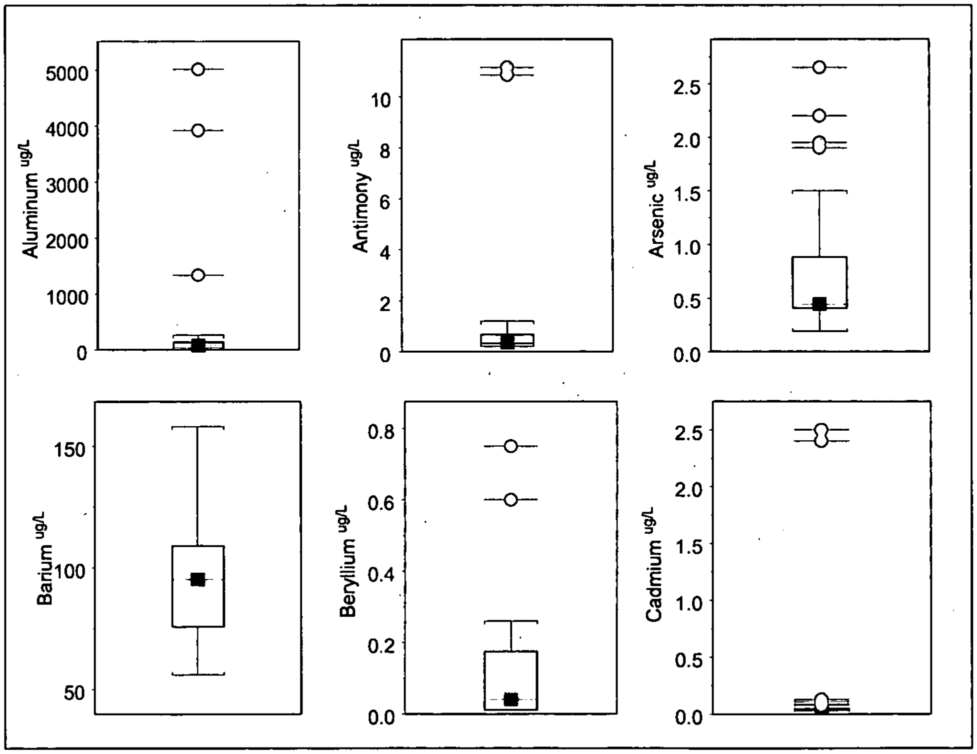

Figure 14-3. Total Metals Box Plots for Location GS01: Aluminum through Cadmium.

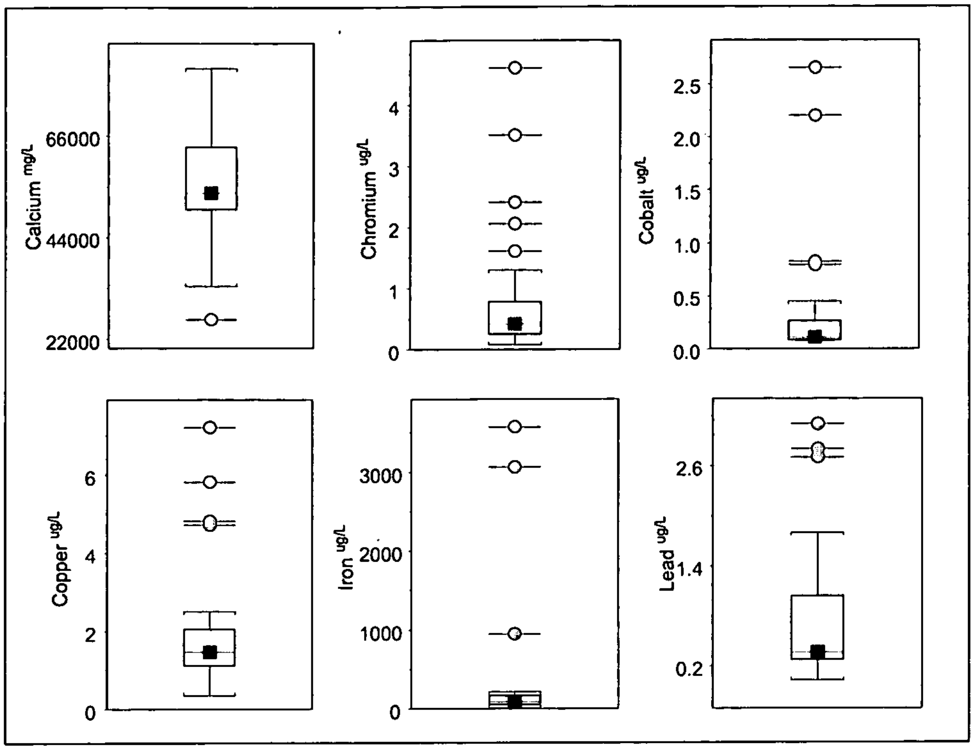

Figure 14-4. Total Metals Box Plots for Location GS01: Calcium through Lead.

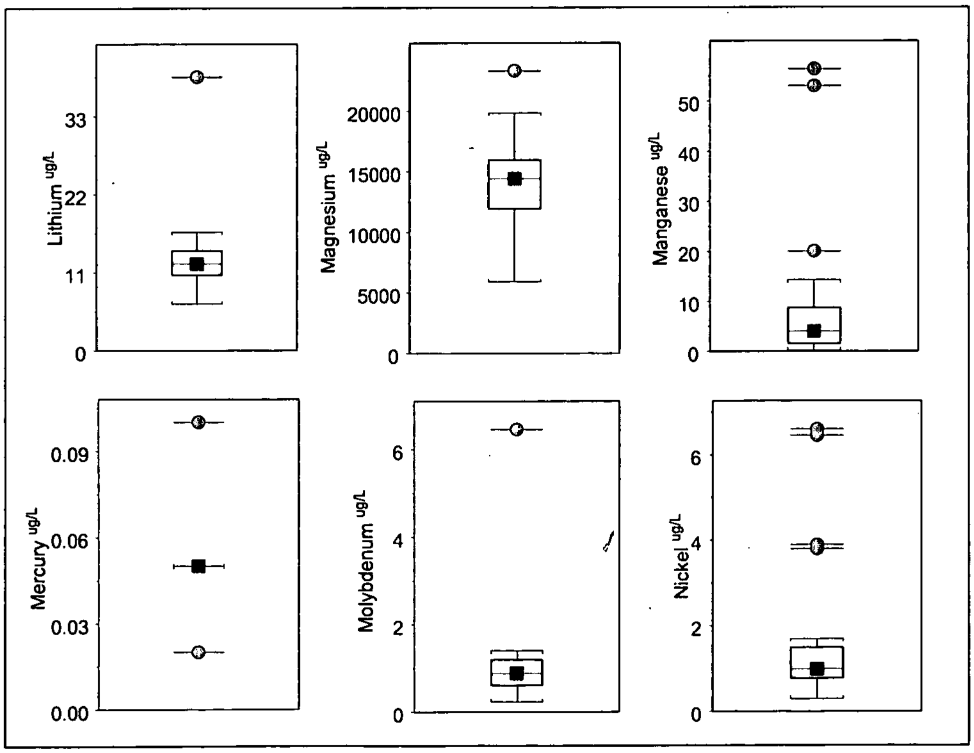

Figure 14-5. Total Metals Box Plots for Location GS01: Lithium through Nickel.

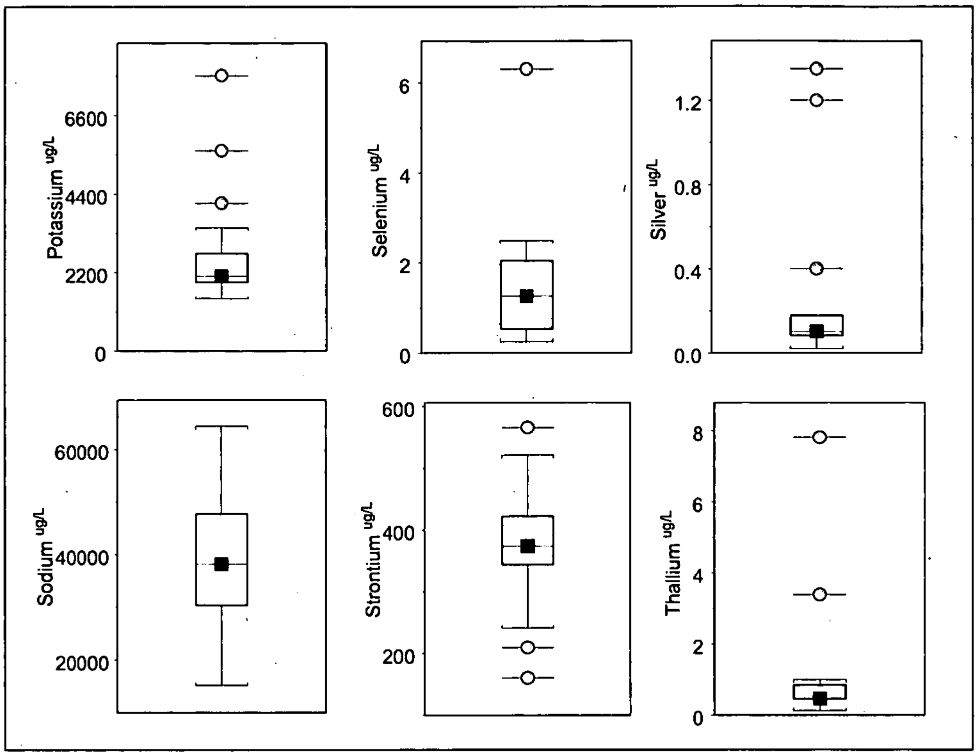

Figure 14-6. Total Metals Box Plots for Location GS01: Potassium through Thallium.

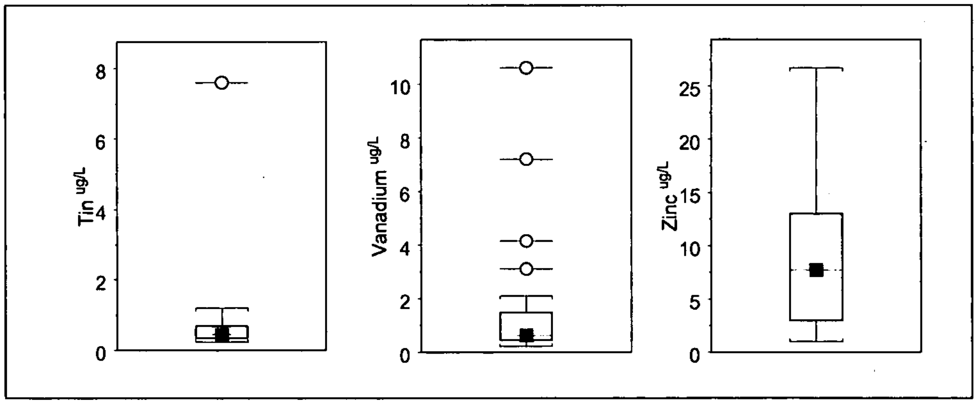

Figure 14-7. Total Metals Box Plots for Location GS01: Tin through Zinc.

14.3.2 Location GS03

Monitoring location GS03 is located on Walnut Creek at Indiana Street. Table 14-7 presents the analyte-specific summary statistics for BZ samples collected at GS03. Figure 14-8 through Figure 14-13 show the analyte-specific box plots for BZ samples collected at GS03. Figure 3-16 shows the drainage area for GS03. The majority of the IA, Pond A-4, and Pond B-5 contribute flow to GS03.

Table 14-7. BZ Summary Statistics for Analytical Results from GS03 in WY97-05.

Analyte	Samples [N]	Undetect	Median	85th Percentile	Maximum
TSS [mg/L]	19	0%	26.0	53.3	160
CHLORIDE [mg/L]	19	0%	99.0	246	340
FLUORIDE [mg/L]	19	0%	0.39	0.62	9.60
SULFATE [mg/L]	19	5%	36.2	55.8	67.0
TOTAL ALKALINITY [mg/L]	18	0%	115	175	200
TDS [mg/L]	13	0%	430	572	680
ALUMINUM [µg/L]	21	0%	591	1890	6000
ANTIMONY [µg/L]	21	33%	0.83	2.30	100.7
ARSENIC [µg/L]	21	10%	1.40	2.65	8.50
BARIUM [µg/L]	21	0%	82.5	97.7	143
BERYLLIUM [µg/L]	21	33%	0.10	0.20	0.60
CADMIUM [µg/L]	21	57%	0.05	0.15	2.40
CALCIUM [µg/L]	21	0%	48400	60200	93900
CHROMIUM [µg/L]	21	5%	1.30	2.10	6.10
COBALT [µg/L]	21	19%	0.98	1.70	2.20
COPPER [µg/L]	21	19%	2.40	3.60	7.40
IRON [µg/L]	21	0%	800	1640	3950
LEAD [µg/L]	21	24%	1.40	2.70	3.50
LITHIUM [µg/L]	20	0%	23.9	29.9	44.9
MAGNESIUM [µg/L]	21	0%	11800	16000	25100
MANGANESE [µg/L]	21	0%	98	189	526
MERCURY [µg/L]	21	100%	0.05	0.05	0.10
MOLYBDENUM [µg/L]	20	5%	2.60	4.54	8.60
NICKEL [µg/L]	21	10%	3.40	4.20	6.45
POTASSIUM [µg/L]	21	0%	6430	8060	9980
SELENIUM [µg/L]	21	81%	0.45	0.75	2.25
SILVER [µg/L]	21	76%	0.13	0.34	2.80
SODIUM [µg/L]	21	0%	62600	125000	149000
STRONTIUM [µg/L]	20	0%	311	444	629
THALLIUM [µg/L]	21	100%	0.45	0.85	2.60
TIN [µg/L]	20	95%	0.45	1.06	7.60
VANADIUM [µg/L]	21	0%	2.90	7.60	14.0
ZINC [µg/L]	21	0%	10.0	22.2	58.0

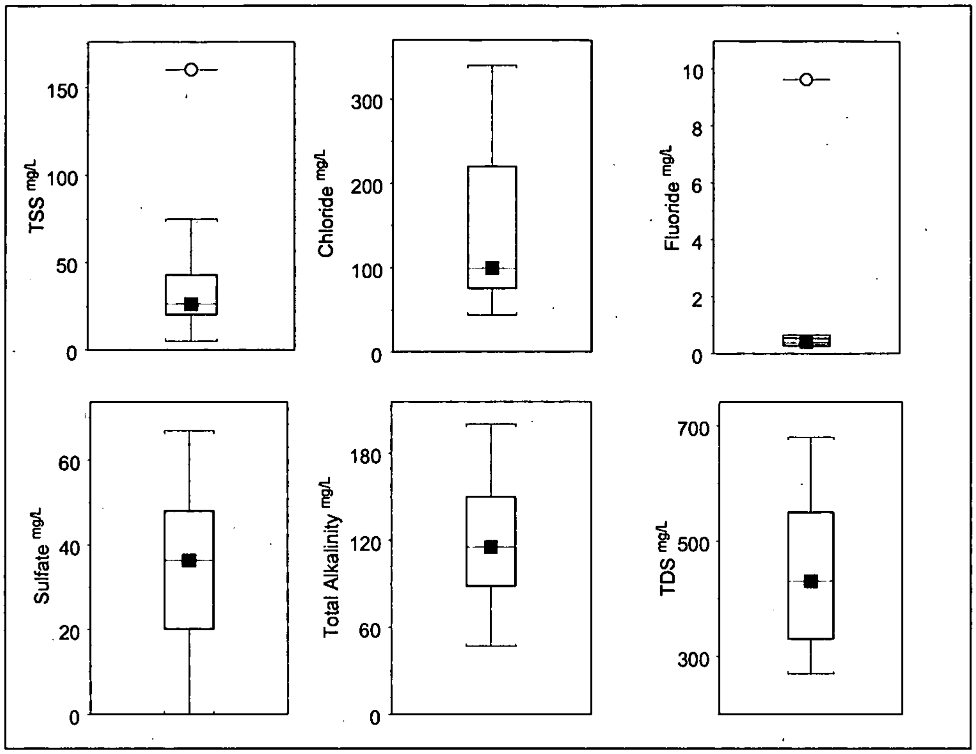

Figure 14-8. Water-Quality Parameter Box Plots for Location GS03.

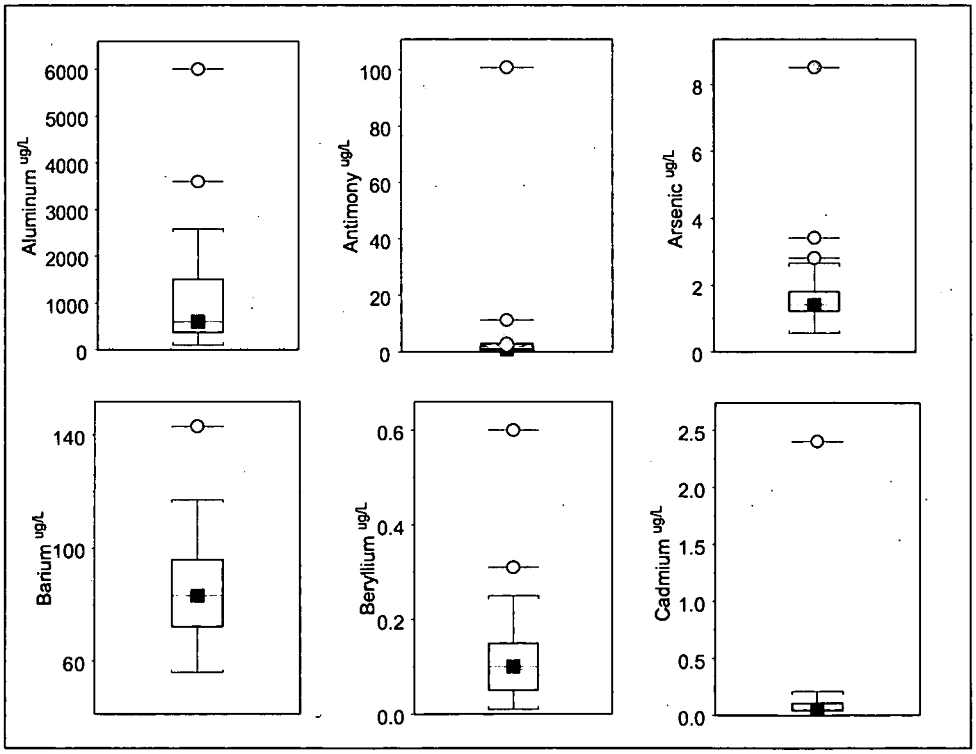

Figure 14-9. Total Metals Box Plots for Location GS03: Aluminum through Cadmium.

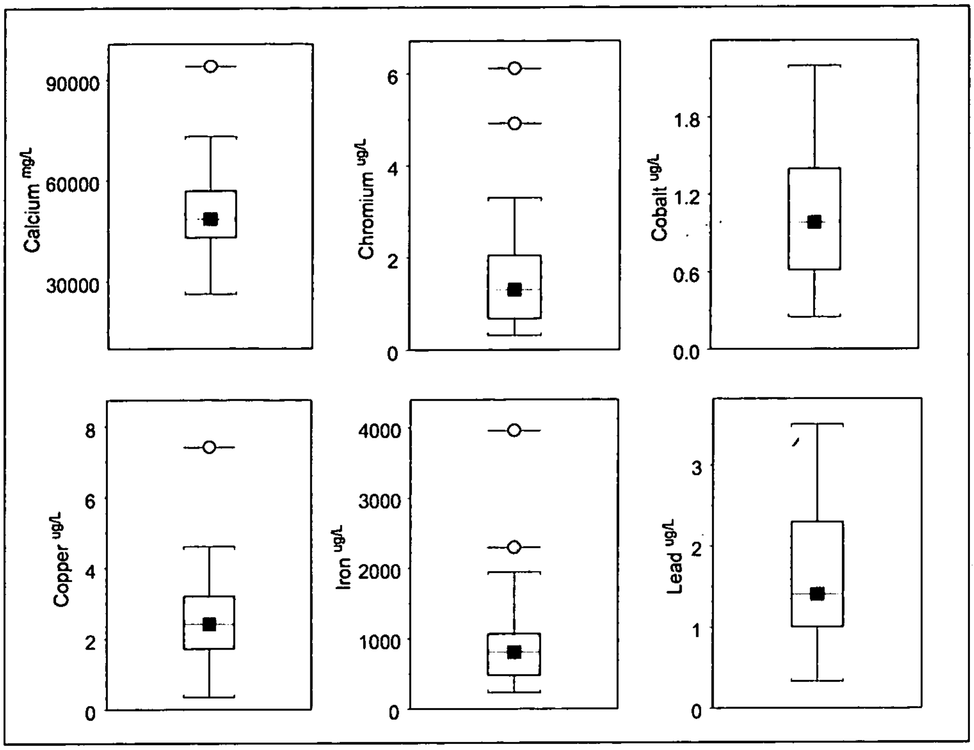

Figure 14-10. Total Metals Box Plots for Location GS03: Calcium through Lead.

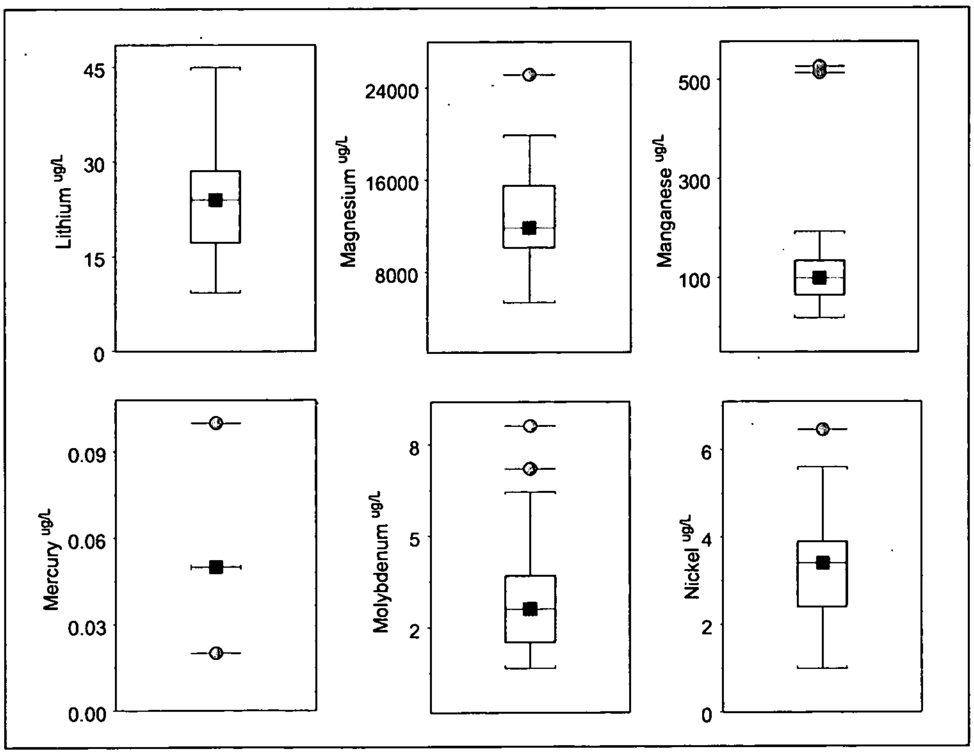

Figure 14-11. Total Metals Box Plots for Location GS03: Lithium through Nickel.

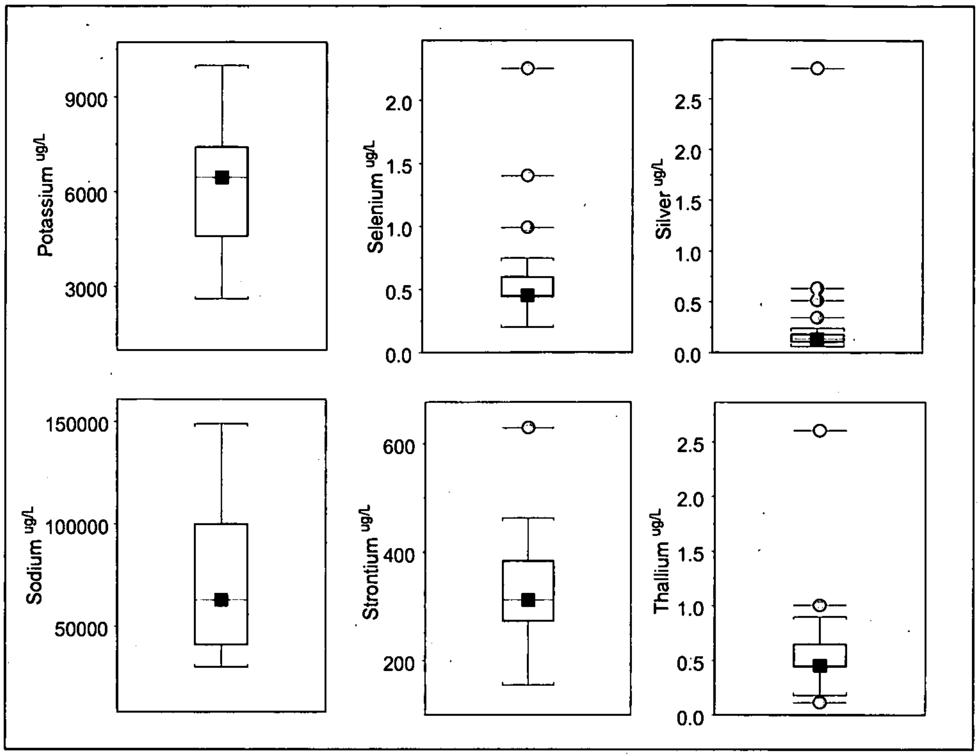

Figure 14-12. Total Metals Box Plots for Location GS03: Potassium through Thallium.

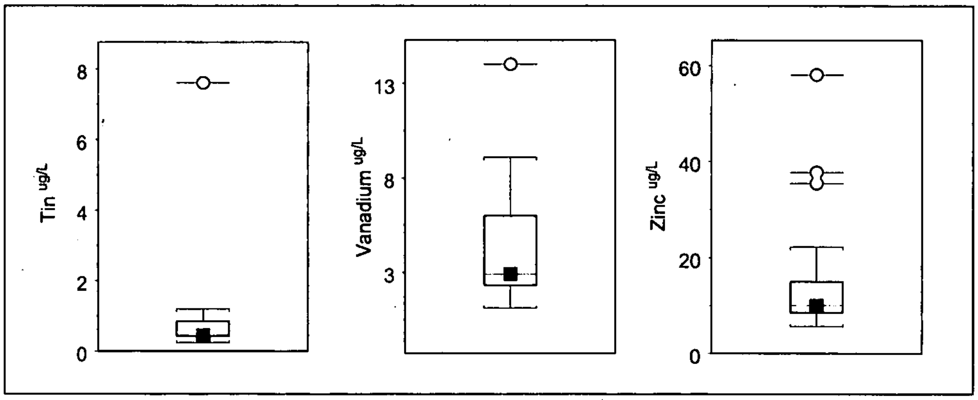

Figure 14-13. Total Metals Box Plots for Location GS03: Tin through Zinc.

14.3.3 Location GS04

Monitoring location GS04 is located on Rock Creek at Route 128. Table 14-8 presents the analyte-specific summary statistics for BZ samples collected at GS04. Figure 14-14 through Figure 14-19 show the analyte-specific box plots for BZ samples collected at GS04. Figure 3-19 shows the drainage area for GS04.

Table 14-8. BZ Summary Statistics for Analytical Results from GS04 in WY97-05.

Analyte	Samples [N]	Undetect	Median	85th Percentile	Maximum
TSS [mg/L]	24	29%	3.7	40.1	220
CHLORIDE [mg/L]	25	0%	18.9	29.0	44.0
FLUORIDE [mg/L]	25	0%	0.39	0.48	0.56
SULFATE [mg/L]	25	0%	32.0	39.4	49.0
TOTAL ALKALINITY [mg/L]	21	0%	110	130	170
TDS [mg/L]	16	0%	240	270	290
ALUMINUM [µg/L]	28	0%	234	3219	11600
ANTIMONY [µg/L]	28	61%	0.49	1.3	11.2
ARSENIC [µg/L]	28	57%	0.78	2.62	3.90
BARIUM [µg/L]	28	0%	82.8	100	132
BERYLLIUM [µg/L]	28	39%	0.08	0.36	0.75
CADMIUM [µg/L]	28	86%	0.05	0.23	2.50
CALCIUM [µg/L]	28	0%	35550	44360	55000
CHROMIUM [µg/L]	28	29%	1.75	3.60	13.0
COBALT [µg/L]	28	57%	0.27	2.19	3.20
COPPER [µg/L]	28	18%	1.80	4.38	7.70
IRON [µg/L]	28	0%	270	2355	8100
LEAD [µg/L]	28	46%	0.88	1.80	7.30
LITHIUM [µg/L]	24	0%	12.4	16.1	113
MAGNESIUM [µg/L]	28	0%	8520	10100	12600
MANGANESE [µg/L]	28	7%	13.9	42.1	103
MERCURY [µg/L]	28	93%	0.05	0.10	0.32
MOLYBDENUM [µg/L]	24	38%	0.53	1.01	6.45
NICKEL [µg/L]	28	18%	2.50	6.43	11.1
POTASSIUM [µg/L]	28	0%	1895	3325	8200
SELENIUM [µg/L]	28	68%	0.60	2.09	3.10
SILVER [µg/L]	28	79%	0.13	0.87	1.35
SODIUM [µg/L]	28	0%	22350	26915	35000
STRONTIUM [µg/L]	24	0%	210	269	337
THALLIUM [µg/L]	28	86%	0.47	1.00	8.00
TIN [µg/L]	24	88%	0.46	0.85	7.60
VANADIUM [µg/L]	28	18%	1.60	7.08	24.0
ZINC [µg/L]	28	7%	7.20	16.4	35.9

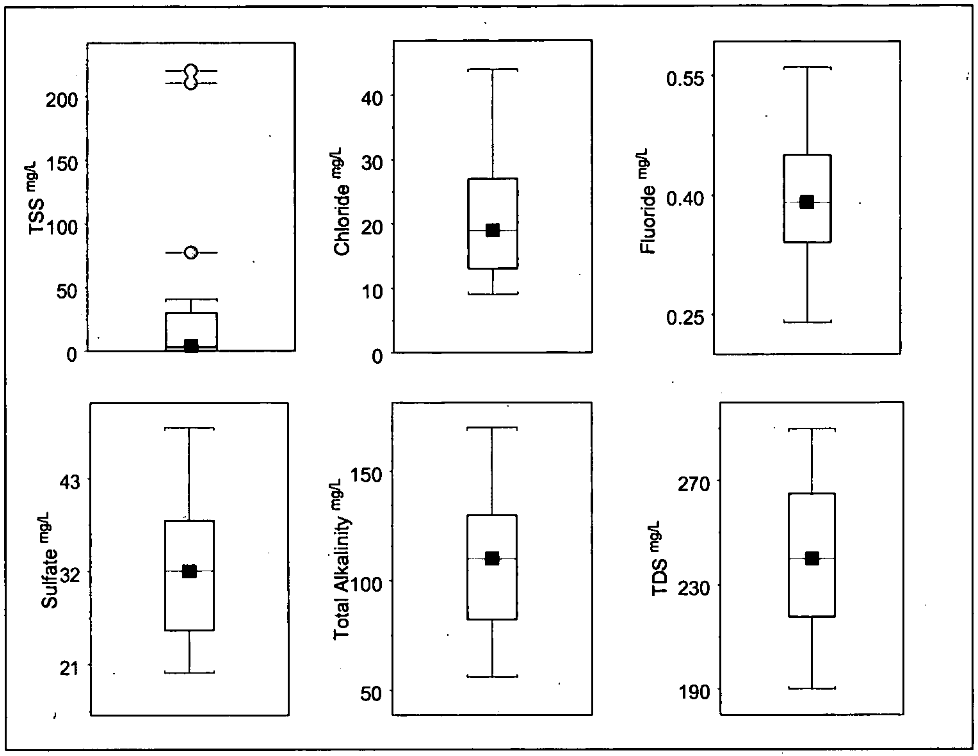

Figure 14-14. Water-Quality Parameter Box Plots for Location GS04.

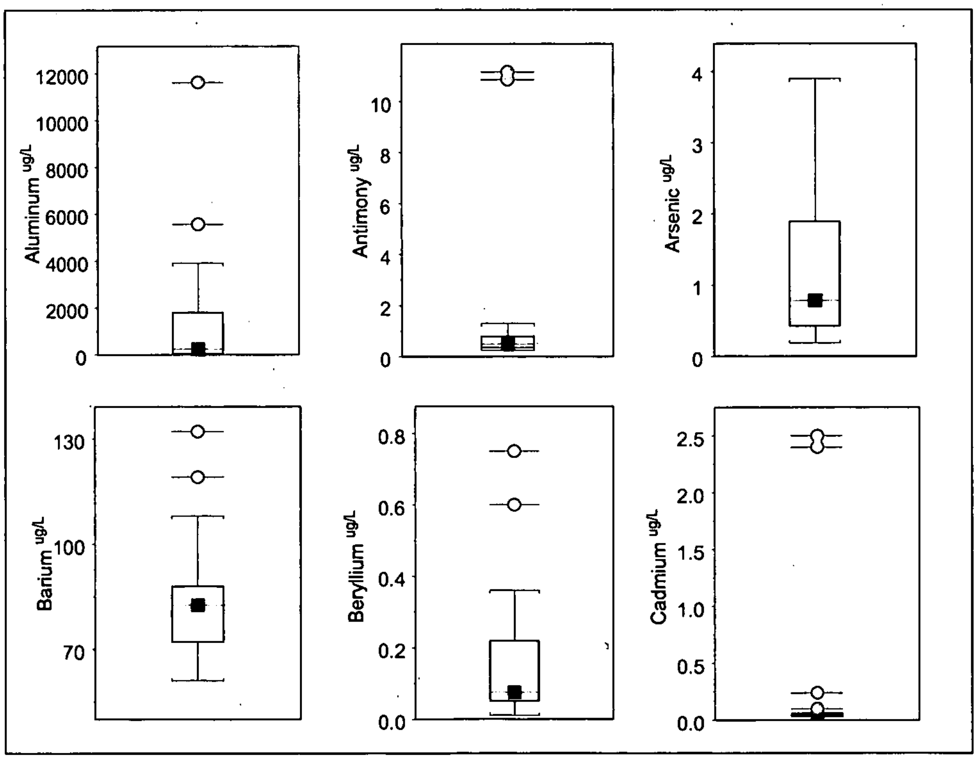

Figure 14-15. Total Metals Box Plots for Location GS04: Aluminum through Cadmium.

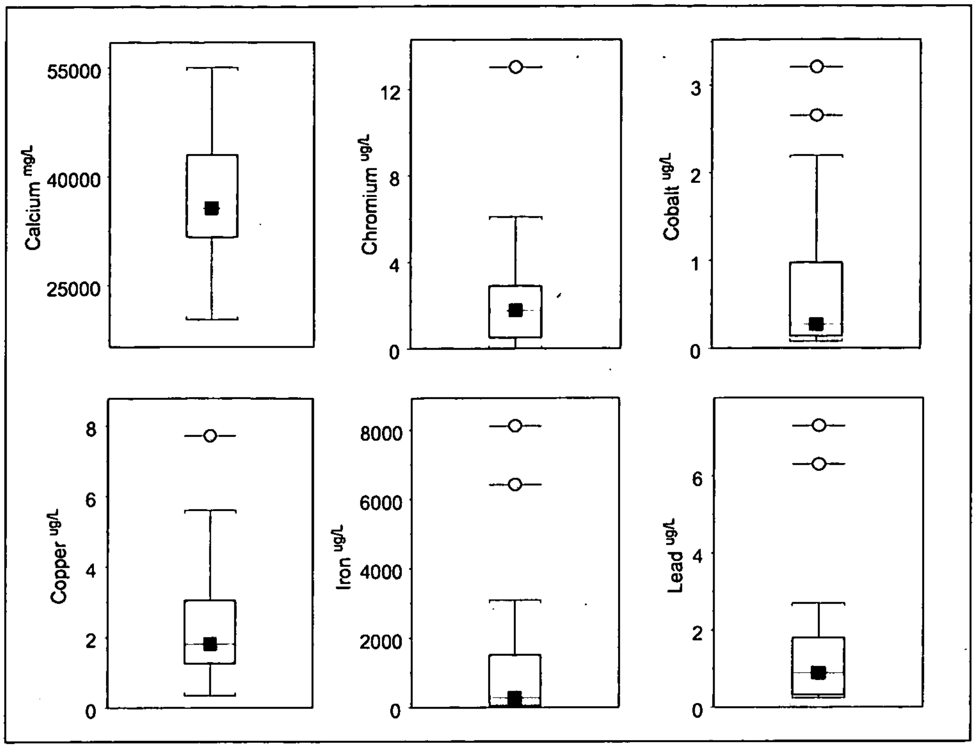

Figure 14-16. Total Metals Box Plots for Location GS04: Calcium through Lead.

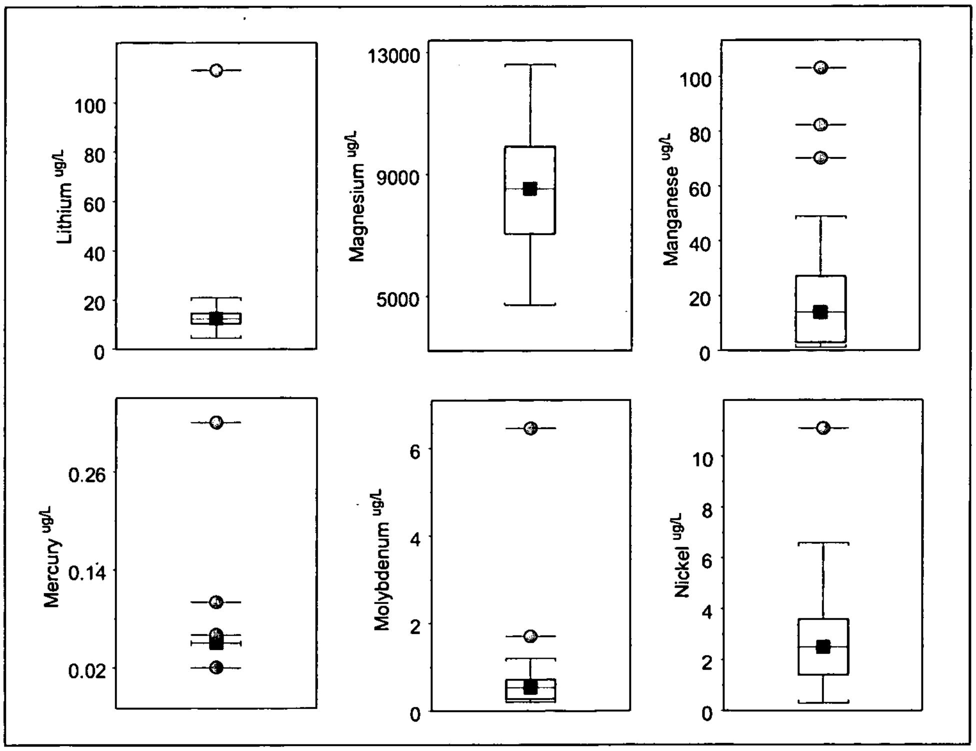

Figure 14-17. Total Metals Box Plots for Location GS04: Lithium through Nickel.

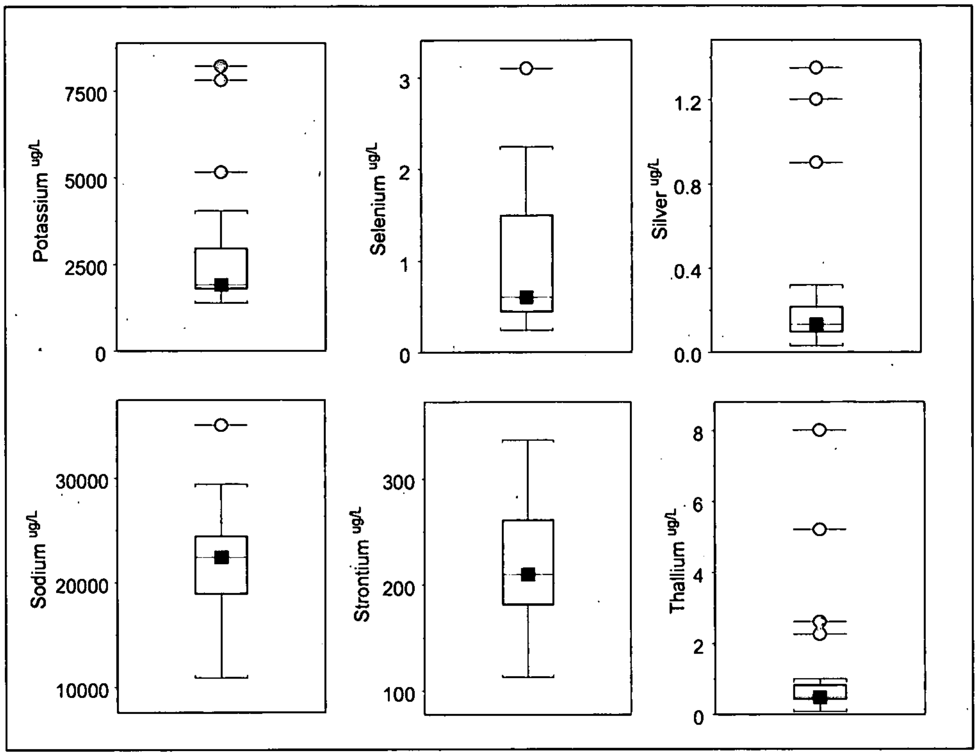

Figure 14-18. Total Metals Box Plots for Location GS04: Potassium through Thallium.

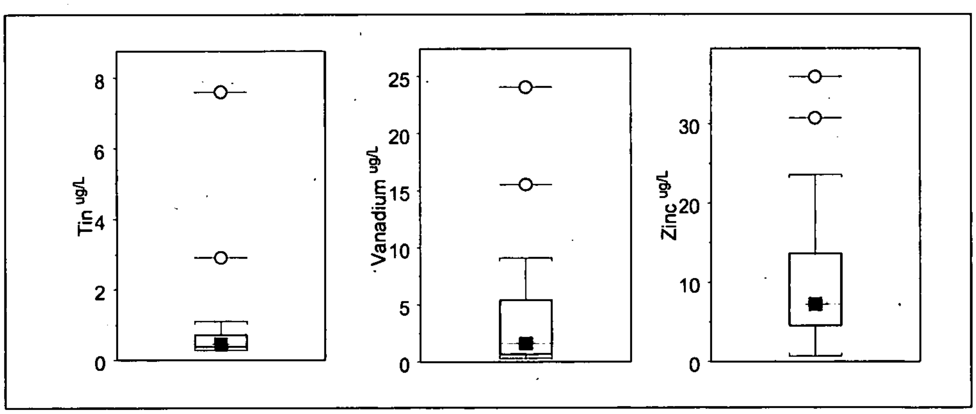

Figure 14-19. Total Metals Box Plots for Location GS04: Tin through Zinc.

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15. VALIDATION AND DATA QUALITY ASSESSMENT

Data validation and verification (V&V) is performed by the Analytical Services Division (ASD). Data quality assessment (DQA) is performed by Surface-Water Program personnel at RFETS. The following section distinguishes DQA from data validation, and discusses the technical basis, equations, and criteria used for DQA of surface water.

15.1 GENERAL DISCUSSION

Data V&V procedures are the principal means of assessing the usability of surface-water analytical data. V&V also improves overall data quality by allowing ASD to closely monitor laboratory performance and to provide feedback to each laboratory regarding its ability to produce quality data that meets subcontract requirements. Information from V&V enables ASD to direct analytical work to laboratories that demonstrate superior performance by generating timely, high quality analytical data for RFETS.

Data validation is a rigorous data review performed by a K-H ASD subcontractor on approximately 25% of the surface-water analytical data generated by RFETS. The remaining 75% of the data are verified under less extensive data reviews than validation. V&V criteria are generally based on government-published standards and guidelines, primarily EPA Contract Laboratory Procedures (CLP) and SW-846 method guidelines for organic and inorganic data evaluation and review. V&V are technically specialized data evaluations and are usually performed by analytical chemists. V&V work for RFETS is performed in accordance with a set of ASD procedures, some of which are listed below.

- K-H, 2002, General Guidelines for Data Verification and Validation, DA-GR01-v2, 10/1/02.
- K-H, 2002, Verification and Validation Guidelines for Volatile Organics, DA-SS01-v3, 10/1/02.
- K-H, 2002, Verification and Validation Guidelines for Inorganic Metals, DA-SS05-v3, 10/1/02.
- K-H, 2002, Verification and Validation Guidelines for Radionuclides by Gamma Spectrometry, DA-GAM-v1, 6/4/02.

All surface-water analytical data collected by RFETS are considered valid (V or V1) unless the V&V process identifies analytical problems that require the data to be qualified. When it is necessary to qualify individual data records, standard qualifier codes (alphanumeric validation codes) are applied. Integer "reason codes" accompany these validation codes, enabling the data user to determine why the results were qualified.

Common data qualifiers are defined below. Please refer to ASD documents for a complete list and formal definitions.

- V Valid data. Validation found no problems with the results.
- V1 Valid data. Verification found no problems with the results.
- 1 This code is often assigned to the original "TR1" record when a sample is re-analyzed. The re-analysis "TR2" may have a "V1" code.
- J The analytical result is estimated.
- U The analytical result is considered un-detected (non-detect).
- JB Result is <RDL and estimated due to blank contamination.
- NJ The result is presumptively estimated.
- UJ The result is estimated at an elevated detection limit.
- R Unusable data, rejected by validation.
- R1 Unusable data, rejected by verification.

V&V focuses on evaluation of laboratory quality control data such as method blanks, laboratory control samples (LCS), and spike recoveries. It also checks for adherence to sample and extract holding times, standard analytical methods, contractual requirements, and proper documentation.

Although DQA and V&V examine some of the same quality control data, they do so from different perspectives. DQA (in this report) looks at the overall quality of an entire water year of surface-water data, in contrast to V&V, which looks at the analytical details of individual data packages. V&V focuses on laboratory methodology, while DQA focuses on interpretation of data describing QC samples that originated in the field, such as "field duplicate" samples and "equipment rinsate" samples.

In contrast to V&V, the DQA performed by Surface-Water Program personnel at RFETS, does not assign data qualifiers to individual analytical results or data packages. DQA is a second level of QA intended to be a general assessment of how well the Surface-Water data-collection program is operating. The DQA is performed by evaluating water quality data in terms of the precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters.

15.2 PARCC PARAMETERS

Use of the PARCC parameters for DQA has been promoted by EPA guidance documents. Accuracy and precision are quantitative measures. Representativeness and comparability are qualitative measures. Completeness is a combination of both quantitative and qualitative measures.

Surface-Water Program personnel evaluate the PARCC parameters by following guidelines published in the following QC documents.

- RMRS, 1998, Procedure for Evaluation of Data for Usability.
- RMRS, 2000, Quality Assurance Program Plan for the Automated Surface-Water Monitoring Program. RF/RMRS-2000-013, Revision 0, March 2000.
- RMRS, 2001, Quality Assurance Program Plan for the Groundwater Monitoring Program Rocky Flats Environmental Technology Site.

The following subsections discuss the PARCC parameters and the types of data available to assess them.

15.2.1 Criteria for Precision

The precision of a measurement is an expression of the mutual agreement between duplicate measurements of the same property taken under similar conditions. Precision can be expressed quantitatively by the relative percent difference (RPD) between real and field duplicate samples for metals, volatile organic compounds, polychlorinated biphenyls and water quality parameters as defined by the following equation:

$$RPD = \frac{|(S-D)|}{(S+D)/2} * 100$$

where: S = Concentration of analyte in Real Sample

D = Concentration of analyte in Duplicate Sample

The RFETS Surface-Water Program uses the "Duplicate Error Ratio" (DER) to quantify the precision of radionuclide activity data:

$$DER = \frac{|(S-D)|}{\sqrt{[(TPU_S)^2 + (TPU_D)^2]}}$$

where: TPU_S = Total Propagated Uncertainty of the Sample

TPU_D = Total Propagated Uncertainty of the Duplicate

S = Sample Result

D = Duplicate (or Lab Replicate) Result

Because TPU is seldom reported with radionuclide activity data, the two-sigma error or random counting error has been substituted for TPU in the uranium, americium/plutonium and strontium calculations made for this report.

The RFETS QC criterion for surface-water RPDs is that individual RPDs should be ≤30%. The analogous criterion for DERs is to be ≤1.96. The overall goal for the surface-water dataset is to have 85% of the RPD and DER values comply with the QC criteria.

15.2.2 Criteria for Accuracy

Accuracy is the degree of agreement for a measurement with an accepted reference or true value and is a measure of the bias in a system. The closer the measurement is to the true value, the more accurate the measurement. The RFETS V&V process is the principal means for evaluating the accuracy of analytical results.

Accuracy assessment for PARCC evaluations is based on the Procedure for Evaluation of Data for Usability (RMRS, 1998). Because the RFETS V&V process compares the actual analytical methods used by each laboratory to the contract-required analytical methods, the Surface-Water Program does not repeat this evaluation.

Matrix spike (MS) and matrix spike duplicate (MSD) recoveries are reported by the analytical laboratories for most non-radionuclide analytical suites. Criteria for acceptable MS recoveries vary between laboratories, depending on the analyte, and the analytical method. The Surface-Water Program criterion for acceptable MS results ranges from 75 to 125% recovery.

Laboratory control sample (LCS) recoveries for radionuclides are often available for surface-water quality data. According to ASD, laboratories in practice will commonly accept LCS values in the range of 70-130%. LCS percent recoveries between the 70-130% laboratory range and the 75-125% QC range required by the ASD laboratory contracts are examined by data validators for acceptability on an analyte-by-analyte basis. The Surface-Water Program criterion for acceptable LCS recoveries ranges from 75 to 125% recovery.

Because some laboratories reported LCS results in pCi/L, while others calculated % recovery, ASD implemented a new reporting criterion, "relative bias". The relative bias criterion is defined in the BOA by the following formula (see Page J-6 of the National BOA, section 2.3.2.5):

Relative Bias = (Observed – Known) / Known

where: Observed = measured activity of LCS standard (pCi/L)

Known = known activity of LCS standard (pCi/L)

Acceptable values for relative bias results range from –0.25 to +0.25. ASD requested that laboratories begin reporting relative bias calculations for LCS samples in November 2001, and actual reporting began during the First Quarter of 2002.

15.2.3 Criteria for Representativeness

Representativeness in DQA is limited to an evaluation of whether analytical results for field samples are truly representative of environmental concentrations, or whether they may have been influenced by the introduction of contamination during collection and handling. The potential introduction of contamination is commonly evaluated by examination of the analytical results for equipment rinsates.

Equipment rinsates are used to assess the efficacy of the decontamination process used to clean surface-water sampling equipment. Analytes detected in rinsate samples indicate possible cross-contamination between environmental samples. In many environmental sampling programs, rinsates are samples of volatile-free "distilled" water that have been poured over or through decontaminated sampling equipment and subsequently handled in the same manner as environmental samples. However, the Surface-Water Program samples water over time and collects the water in carboys. Therefore, a location-specific "rinse carboy" is prepared using distilled water. This carboy is treated the same as other surface-water samples from that location, and analyzed for the same parameters. Analytical data from these rinse carboys are used to assess how well the carboys were cleaned between field deployments and to determine if contamination was introduced during sample preparation.

Although rinsates are used specifically as indicators of cross-contamination from improper decontamination of equipment, they are carried through the entire sampling, shipping, and laboratory process. Therefore, they are good indicators of potential contamination introduced during any of these steps. Because rinsate samples are judged adequate to assess introduced contamination, the Surface-Water Program does not use "trip blanks" in its QA program.

15.2.4 Criteria for Completeness

A qualitative measure of completeness is the rate of successful sampling. The DQA verifies that all planned samples were collected, unless insufficient water was available for sampling. The completeness goal for successful sampling is the collection of at least 90% of the planned samples. However, the availability of surface water is outside the control of the Surface-Water Program. If all required stations were visited, sampling completeness is considered acceptable.

Completeness as a quantitative measure of data quality may be expressed as the percentage of valid or acceptable data obtained from a measurement system. ASD tracks analytical laboratory performance through both the shipment of samples to the laboratory and the receipt of data from the laboratory. Therefore the Surface-Water Program does not track the timeliness of data receipt from the laboratories, but evaluates data completeness on the following formula:

$$Completeness = DP_u = \frac{DP_t - DP_n}{DP_t} * 100$$

where: DP_u = Percentage of usable data points

DP_t = Total number of data points

DP_n = Non-usable (rejected) data points

The completeness criterion is having $\geq$ 90% valid samples.

15.2.5 Criteria for Comparability

Comparability is a qualitative parameter. Consistency in the acquisition, handling, and analysis of samples is necessary for comparing results. Data developed under the Surface-Water Program are collected in accordance with RFETS SOPs, transported per RFETS SOPs and US-DOT shipping regulations, and analyzed using standard EPA, or nationally recognized analytical methods. This helps to ensure comparability of results with other analyses performed in a similar manner.

ASD verifies that laboratory analyses are performed according to the standard protocols specified by the RFETS subcontract to each laboratory. Therefore, the analytical results should be comparable to data produced by similar methods.

15.3 SURFACE-WATER DQA RESULTS WY05

During WY05, 37 automated surface water locations were sampled one or more times. This resulted in a total of 356[67] surface water samples collected versus 498 last year. During WY05, 820 bottles of water were submitted to analytical laboratories for analysis versus 1,167 last year. The following table breaks this data down by sample type.

Table 15-1. WY05 Sample Type Breakdown.

	Unique Water Samples	Unique Bottle Codes
Primary samples (REALs)	326	751
Field duplicates (DUPs)	16	39
Rinsates (RNSs)	11	30
Totals	353	820

Data used to evaluate the PARCC parameters are included in the available WY05 analytical data generated by the laboratories. These include analyses of field duplicate and rinsate quality control samples submitted to the laboratory, and laboratory generated QA/QC samples such as Lab Control Samples (LCS). The DQA of these analyses is discussed below by each PARCC parameter.

As of the publication of this report, QA/QC information was not available for all samples. Therefore, the assessment is performed using all available information. The following list details the deficiencies:

- Three continuous flow-paced samples started in WY05 have insufficient volume for analysis. The samples remain in progress in the field.
- Metals results for three samples have not been returned by the laboratories.
- Validation qualifiers for metals results for two samples have not been completed.

15.3.1 Precision During WY05

Duplicate error ratios (DER) are indicators of precision for radionuclide analyses. The QC criterion for precision requires that individual DER values should be $\leq$1.96, and overall the dataset should have $\geq$85% compliance with the criterion. Appendix Table B-4 is a tabulation of the DER values for WY05 radionuclide analyses. The table has been sorted by the DER parameter so that the range of values is apparent. The DER range is from 0.00 to 0.83.

Table 15-2 summarizes the DER findings of Table B-4 and indicates if the 85% goal has been met. Overall, 100% of the DER data are in compliance with the criterion, indicating excellent precision for radionuclide analyses.

Table 15-2. Summary of Duplicate Error Ratio (DER) Values.

Analyte Group	Total Number of DER Results	Number of Unacceptable Results DER>1.96	Number of Acceptable Results	Percentage Acceptable	Goal Met
Radionuclides	80	0	80	100%	Yes

[67] Results for 353 samples were available for evaluation.

Relative percent difference (RPD) between real and field duplicate sample results is an indicator of precision for non-radionuclide analyses. Individual RPD values should be ≤30% and at least 85% of the RPDs should comply with the criterion. Appendix Table B-5 tabulates RPD values and is sorted first by analyte suite, then by RPD, in order to highlight the RPD range of each suite. RPD values for metals ranged from 0.0% to 129.3%; and RPDs for water quality parameters varied from 0.0% to 36.6%.

Table 15-3 summarizes the RPD findings of Table B-5 and indicates if the 85% goal has been met. During WY05, the RPD goal was met for metals and for water quality parameters. Overall, the non-radionuclide data had 96.5% acceptable RPDs, and therefore exceeded the 85% goal.

Table 15-3. Summary of Relative Percent Differences (RPD) Values.

Analyte Group	Total Number of RPD Results	Number of Unacceptable Results RPD>30%	Number of Acceptable Results	Percentage Acceptable	Goal Met
Metals	278	9	269	96.8	Yes
WQP	9	1	8	88.9	Yes
Totals	287	10	277	96.5	Yes (overall)

15.3.2 Accuracy During WY05

MS recoveries provide another measure of accuracy. Appendix Table B-6 displays recoveries for 723 MS and MSD analytical records for metals and water quality parameters (WQP). This data is summarized in Table 15-4. The metals suite missed the QC goal of 90% by having 85.6% of its recoveries falling in the range 75% to 125%. WQP met the goal with 100% of their spike recoveries falling in the acceptable range. Overall, across all analytical suites, the percentage of acceptable MS/MSD results was 87.3%, just missing the accuracy goal of 90%. The dataset is so close to meeting the goal that the data are considered to have good accuracy.

Table 15-4. Summary of MS and MSD Recovery Data.

Analyte Group	Total Number of MS & MSD Results	Number of Low Results Below 75%	Number of High Results Above 125%	Number Acceptable	Percentage Acceptable	Goal Met
Metals	641	36	56	549	85.6	No
WQP	82	0	0	82	100	Yes
Totals	723	36	56	631	87.3	No (overall)

Appendix Table B-7 contains 598 relative bias values for LCSs. These are used by RFETS to evaluate the accuracy of radionuclide analyses. The QC criterion for the acceptable range of relative bias values is from –0.25 to +0.25. During the WY05, the bias ranged from -1.0 to +0.171. Only four records were less than -0.25 (one each Pu-239/240, Am-241, U-233,234, U-238), while 99.3% of the data met the QC criterion.

LCS results for non-radionuclide suites were available for metals and water quality parameters (including anions). These LCS recoveries are tabulated in Appendix Table B-8, which is sorted by analyte group, then by percent recovery. There are 2,589 LCS data records for metals. Except for 1 lithium record, all of the LCS recoveries for metals fell in the range 90.8% to 118% and were within the 75% to 125% acceptable QC range. There are 186 LCS data records for WQPs. LCS recoveries for WQPs fell between 86% and 110% and were all acceptable. Overall for non-radionuclides, 99.96% of the LCS recoveries indicate that WY05 surface water analytical data for metals and water quality parameters are of high accuracy.

Another aspect of accuracy is "rejected data". Out of 6,717 analytical records representing reals, duplicates and rinsates during WY05, only 73 records were rejected (R or R1 qualified) during data V&V. Another way to state this is that 98.9% of the analytical data collected during the year were considered to be valid and usable. Appendix Table B-9 lists the 73 rejected records, which were for antimony, mercury, TSS, Am-241, Pu-239/240, and uranium isotopes.

15.3.3 Representativeness During WY05

As defined earlier, representativeness is an evaluation of the sampling procedure for its ability to reflect the true concentrations of contaminants in surface water. Equipment rinsate samples (rinse carboys) are used by the RFETS Surface Water Program to determine whether there is introduced contamination from improper or incomplete decontamination of the sampling equipment.

During WY05 a total of 128 rinsate analytical records were generated for metals, radionuclides, and water quality parameters. The majority of these records lack evidence of contamination. The remaining 24 records are tabulated in Appendix Table B-10, and 21 of these are B-qualified metals data which constitute only weak evidence of contamination. The "B"qualifier indicates that the metal concentrations are above the instrument detection limit, but below the method detection limit.

Only 3 records (at the top of Table B-10) provide substantial evidence of inadequate decontamination of a sample carboy. Overall, there is very little evidence of introduced contamination during WY05 surface water sampling and/or shipping activities. Most of the 128 rinsate records appear to be clean. Therefore surface water quality data for the year are judged to be representative of the actual surface water concentrations.

Because all required sampling locations were visited, and the samples that could be collected were analyzed, analyses for the year are judged to be representative with respect to spatial coverage.

15.3.4 Completeness During WY05

If sufficient surface water is available for sampling, the goal is to have ≥90% successful sampling of all required stations. However, the availability of surface water is beyond the control of the samplers. Surface water monitoring during WY05 required sampling at up to 37 gaging stations and surface water sampling locations. In actuality, samples were collected at each of the 37 sites and were submitted to the laboratory for analysis. Therefore the sampling success rates for each requested analytical suite was 100%. Because all requested stations were sampled during WY05, sampling completeness exceeded the goal.

V&V completeness is summarized in Table 15-5. This table compiles by analytical suite (actually by SWD line item code, LIC), the total number of data points for reals, duplicates and rinsate samples. It then subtracts rejected data points, and subtracts points that lack validation qualifiers. The result is the net number of usable validated or verified data points, and this is expressed as % usable data, or % V&V completeness. The QC goal for completeness is ≥90%. Note that only analytical data are validated, so Table 15-5 excludes physical methods such as sieving.

Validation completeness for all metal, radionuclide, and WQP suites exceeded 97% and exceeded the completeness goal. Many of the suites had 100% validation completeness. Therefore from the perspective of V&V completeness, the WY05 surface water data are acceptable.

Another measure of completeness is that an adequate number of QC samples (field duplicates and equipment rinsates) must be collected to meet QC requirements. The recommended frequency for collecting duplicate samples is one duplicate (DUP) per 20 or fewer primary (REAL) water samples. In other words, duplicates should be collected at a 5% or greater frequency per REAL sample. Like duplicates, rinsate samples (RNS) are also to be collected at a 5% or greater rate.

The sample collection frequencies of REAL, DUP, and RNS samples are tabulated by analyte suite in Table 15-6.

The ratios of REAL/DUP samples shown in Table 15-6 meet Surface Water program QC goals with one DUP per 19 REALs. Across all analyte suites and samples collected during the year, the overall frequency of duplicates was 5.21%, exceeding program goals (≥5%).

The ratios of REAL/ RNS samples in Table 15-6 do not meet program QC goals with one rinsate per 25 REALs. Overall, across all suites and samples collected during the year, the rinsate collection frequency was only 4.0%, missing the program goals (≥5).

15.3.5 Comparability During WY05

No changes were made to surface-water sampling or to analytical procedures during WY05. Therefore, the analytical data generated during the year should be comparable to corresponding analyses from previous years.

Table 15-5. Summary of Validation and Verification Data Completeness.

Chemical Group	Analytical Method	Line Item Code	Number of Data Points	Number of Unvalidated Points	Number Rejected	Net Usable Points	Completeness	Goal Met
Metals	EPA 600	MET-A-013	4561	54	29	4478	98.18	Yes
Metals	EPA 600	MET-A-014	8	0	0	8	100.00	Yes
Metals	EPA 600	RME-A-001	126	0	0	126	100.00	Yes
Metals	EPA 600	RME-A-002	124	0	0	124	100.00	Yes
Radionuclides	ALPHA SPEC	RAS-A-001	1705	0	42	1663	97.54	Yes
Radionuclides	ALPHA SPEC	RAS-A-004	18	0	0	18	100.00	Yes
WQP	E130.2, SM 2340C	WCH-A-019	65	0	0	65	100.00	Yes
WQP	E160/SM2540 SOLIDS ANALYSIS	WCH-A-034	110	0	2	108	98.18	Yes
			Sum of Number of Data Points	Sum of Number of Unvalidated Points	Sum of Number Rejected	Sum of Net Usable Points	Overall Completeness	Goal Met
Totals			**6717**	**54**	**71**	**6592**	**98.14**	**Yes**

Table 15-6. Summary of Field Quality Control Samples and Data Records.

Analyte Group	Analytical Method	Line Item Code	Number of Locations Sampled for REALs	Number of Locations Sampled for DUPs	Number of Locations Sampled for RNSs	Ratio REALs/ DUPs (Goal <20)	Ratio REALs/ RNSs (Goal <20)	Number REAL Records	Number DUP Records	Number RNS Records	Total Records
Metals	EPA 600	MET-A-013 MET-A_014 RME-A-001 RME-A-002	27	7	5	19.57	34.25	4475	278	66	4819
Radionuclides	ALPHA SPEC	RAS-A-001 RAS-A-004	36	11	10	20.06	32.10	1593	80	50	1723
WQP	E130.2, SM 2340C; E160/SM2540 SOLIDS ANALYSIS	WCH-A-019 WCH-A-034	27	7	10	17.11	12.83	154	9	12	175
Totals						**19.21**	**24.97**	**6222**	**367**	**128**	**6717**
Percentages						**5.21%**	**4.00%**		**5.90%**	**2.06%**	

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